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# ENGINEERING GUIDE FOR FIRE PROTECTION AND DETECTION SYSTEMS AT ARMY AMMUNITION PLANTS

## VOLUME I SELECTION AND DESIGN

LOUIS JOBLOVE  
MANUEL AVELAR  
NORVAL DOBBS  
AMMANN & WHITNEY  
TWO WORLD TRADE CENTER  
NEW YORK, NEW YORK 10048

LEONARD FRANK  
ARRADCOM

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**US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND**  
**LARGE CALIBER**  
**WEAPON SYSTEMS LABORATORY**  
**DOVER, NEW JERSEY**

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This report presents guidelines for the design of fire protection systems for use in Army Ammunition Plants. Reference is made to existing published standards for fire protection systems and applications of standard and specialized systems. Also presented are approaches to estimating fire protection systems cost.		



## FOREWORD

This is Volume I of a two-part report which assembles into one document basic guidelines and criteria for the design and testing of fire protection and detection systems for use at Army Ammunition Plants. Volume I covers "Selection and Design" and Volume II covers "Testing" of such systems. The report is intended to serve as a guide for:

1. Managers of plant modernization and expansion programs.
2. Managers of plant safety divisions.
3. Plant fire protection personnel including designers.
4. Other interested Department of Defense fire protection personnel.
5. Architect/Engineer firms involved in the design of facilities for Army Ammunition Plants.

The report places particular emphasis on the "hardened water curtain", which is a blast-resistant fire protection system developed by the Energetic Systems Process Division of the Large Caliber Weapon Systems Laboratory of ARRADCOM for installation in ramps which connect adjoining buildings. A hardened water curtain combines elements of ultra high-speed deluge systems with special piping configurations, and its primary purpose is to reduce the possibility of propagation of fire and explosion from building to building. The report also provides guidelines for conventional fire protection systems.

Reference is made in the report to existing publications of the National Fire Protection Association and governmental and insurance agencies which should be conformed to as applicable, and procedures are outlined for estimating costs for fire protection systems.

In any program for installation of fire protection systems in new or revamped facilities, or for upgrading of existing fire protection, priorities should be established in order to achieve maximum benefit with the available funds. Determining such priorities will require a hazards evaluation of the component areas of the facility, including considerations of personnel exposure, operations critical to production, and dollar value of structures and equipment.



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## SUMMARY

This report is a compilation of basic guidelines and criteria for the design of fire protection and detection systems at Army Ammunition Plants.

The section on Site Water Supply presents general criteria for water supply and distribution systems for fire protection largely by reference to existing publications. Guidelines peculiar to ammunition facilities, such as limitations of hydrant usage and a method of limiting loss of main pressure due to line rupture are also included in this section.

The section on Extinguishing Systems briefly describes conventional automatic sprinkler and spray systems, Halon systems, carbon dioxide systems, hose systems and portable fire extinguishers. Reference is made to existing publications for design requirements, and discussion of applications for the various systems in munitions facilities is included.

The following two sections on Detection Systems and Power Supply provide an overview of available fire detection systems and special requirements for the electrical supplies for such installations, with reference made to applicable publications.

The section titled "Systems for Special Hazards" describes ultra high-speed deluge systems, their applications in munitions facilities, basic guidelines for their design, and some of their limitations.

The section on Hardened Water Curtains describes a new concept which uses a modified ultra high-speed deluge system designed to resist the effects of explosions and prevent the spread of fire through connecting ramps. Guidelines are presented for the application and design of these systems, and there is additional discussion of the use of rate-of-flow devices to limit loss of pressure in the water supply mains in the event of line rupture. A classification of fire protection levels achievable through the use of hardened water curtains and rate-of-flow devices is defined. Finally, to illustrate an approach to selecting appropriate protection levels, the reasoning used in selection of such levels for a melt/pour facility at Lone Star AAP is outlined and summarized in tabular form.

The section on Analysis of Fire Protection Requirements provides a brief description of the relationship between



considerations of hazard probability and severity, and determination of the extent of the fire protection systems that should be provided for a particular facility.

The last section of the report titled "System Costing" provides a summary of major items to be considered in estimating costs for fire protection systems, and concludes with a tabulation of these items and typical applications for the various types of systems.

The appendices are compilations of catalog materials showing some representative examples of various types of fire protection and detection systems and equipment.



## INTRODUCTION

### Background

Fire represents a major hazard to both personnel and facilities of Army Ammunition Plants. In past incidents, fires have resulted in initiation of explosions which have caused loss of life and have produced secondary fires that spread from one building to another via interconnecting ramps and/or secondary explosions. To abort explosive propagation and minimize the spread of fires, fire protection systems of varying design are utilized. These systems may be limited to individual operations, encompass entire buildings, and/or extend between buildings.

Present methods of design of fire protection systems for munitions plants are generally based upon the standards given in National Fire Codes (Ref 1) as published by the National Fire Protection Association and other design manuals as published by various departments of the Department of Defense. Although the data given in these publications are extremely useful, they do not always apply specifically to many of the problems encountered in the design of munitions facilities. Therefore, a study was performed to evaluate those areas where more specific information is required and to assemble into one report all related design criteria. This study was performed by the Energetic Systems Process Division of the Large Caliber Weapon Systems Laboratory, ARRADCOM, as part of its overall "Engineering Support Program" for the Manager of Production Base Modernization and Expansion. This report, which was prepared with the assistance of Ammann & Whitney, Consulting Engineers, summarizes the results of the study and presents recommended criteria for the design of fire protection systems.

### Purpose and Objective

The overall purpose of the study was to assemble into one report recommended design criteria for fire protection systems as used in the design of Army Ammunition Plants. The objectives of the study are summarized below:

1. To present specialized as well as conventional systems and equipment to be used for fire protection; and
2. To present a method of system costing.



### Format and Scope of Report

The following two sections describe the fire protection equipment required for site water supply and extinguishing systems. The next two sections describe fire detection equipment and power supply criteria. These sections are followed by a section on systems for special hazards, a section on hardened water curtains, and a section on the relationship between preliminary hazard analysis and fire protection requirements. The last section presents data relating to systems costing. The appendices contain reproductions of various fire protection and fire detection equipment.

The data presented in this report will permit the selection of various systems and associated equipment needed for the design of the various fire protection systems; whereas the costing data provides a listing of those items required for estimating the cost of the various systems.

Since future standards of measurement in the United States will be based upon the SI Units (International System of Units) rather than the United States System now in use, all measurements presented in this report will conform to those of the SI System. However, for those persons not fully familiar with the SI Units, United States equivalent units are presented in parentheses adjacent to the SI Units.



## SITE WATER SUPPLY

### General

Contained in this section are criteria for sources and distribution systems supplying water for fire protection systems. The codes, standards and other documents referred to should be considered to set forth minimum requirements as general criteria for the design of water supply systems. Specific criteria or directives for a particular application are dependent upon existing facilities and/or their projected uses, and will take precedence over any criteria included in this section.

General criteria for water supplies, including (a) acceptable sources, (b) line pressures and flow rates, and (c) flow duration, are covered in National Fire Codes (NFPA Standards, Ref 1) as follows:

Standard No. 13, Chapter 2: Sprinkler Systems

Standard No. 14, Chapter 5: Standpipe Systems

Standard No. 16, Chapter 3: Foam-Water Sprinkler Systems

Standard No. 24, Chapter 2: Outside Protection.

Section 5 of TM 5-812-1 (Ref 2)

Also applicable are TM 5-813-1 (Ref 3), TM 5-813-2 (Ref 4), TM 5-813-6 (Ref 5), and Chapter 12 of AMCR 385-100 (Ref 6).

General criteria for water tank installations are covered in NFPA Standard No. 22 and in TM 5-813-4 (Ref 7), while criteria for centrifugal fire pump installations are covered in NFPA Standard No. 20. NFPA Standard No. 24, TM 5-813-5 (Ref 8) and TM 5-813-6 (Ref 5) cover general criteria for installation of yard fire main systems.

### Water Supply Capacity

The water supply system should satisfy the following criteria:

1. Supply the flow rate required by the individual fire protection system (or combination of systems likely



to operate simultaneously as a result of a single incident) needing the greatest flow rate, at the pressure required for that system.

2. Supply the flowing pressure required by the individual system (or combination of systems as in Item 1. above) needing the highest pressure, at the flow rate required for that system.
3. Have the capacity to provide the total water volume (flow rate x minimum flow duration) required by the system (or combination of systems as in Item 1. above) with the greatest such requirement.
4. Where the fire protection water and domestic/process water are supplied by a common system, any domestic/process usage that cannot (or must not) be curtailed during a fire should be considered in conjunction with the criteria discussed above.
5. Plant procedures generally do not permit the Plant Fire Department to enter a production area to fight a fire until it has been determined by responsible personnel in the involved area that there is no further danger of explosion. It can, therefore, be assumed that hose streams in a production area will not be used during the time that a fixed automatic extinguishing system is operating in that area. Hydrant flow in such areas, consequently, should not be added to the flow required by any automatic system (in Items 1, 2 and 3 above) but may, by itself, be the controlling factor in determining the required pressure or flow rate.

Existing ammunition facilities generally have water systems supplied from deep wells, storage tanks and/or other resources with distribution system pressures of up to 552 kPa (80 psi). When consistent with safety objectives and economic considerations, new or altered fire protection systems at existing facilities should be designed for satisfactory performance with minimum modifications to the existing water supply systems.

#### Flow Demand and Duration

Required flow demand and duration for ammunition plants should be determined using the criteria in TM 5-812-1 (Ref 2) with the following possible modifications and/or additions:



1. In production areas where plant procedures bar Fire Department personnel while danger of explosion still exists, hose stream demand need not be considered as simultaneous with automatic system demand.
2. For ultra-high speed deluge systems directly protecting a hazardous operation or work station and for hardened water curtains in ramps, the required flow duration need be only 15 minutes.
3. Water application rate (density) for ultra-high speed deluge systems and hardened water curtains should be as described in sections on Systems for Special Hazards and on Hardened Water Curtains, respectively.
4. In a particular area, if each operation or work station involving exposed powder is provided with local ultra-high speed deluge system protection, then sprinklers protecting the structure and overall area may be provided in accordance with criteria for "Ordinary Hazard, Group 3" shown in Reference 2.

Sample: Determination of Required Water Supply System Capacity

In the following example of the determination of required water supply system capacity, four conditions have been assumed as follows:

1. The largest combined flow rate required by systems directly protecting hazardous operations which might be activated as a result of a single incident is considered to occur in a ramp where two hardened water curtains are activated requiring a total of  $3.03 \text{ m}^3/\text{min}$  (800 gpm); required duration - 15 minutes. Also, no building sprinkler or standard deluge systems will be activated by this incident.
2. The largest flow rate required by any building sprinkler or standard deluge system which may be activated as a result of a single incident (other than the one described in 1. above) is  $2.84 \text{ m}^3/\text{min}$  (750 gpm); duration - 90 minutes.
3. Subsequent to either of the above incidents, and after the water mains supplying the systems activated in 1. or 2. above have been shut off, water should be available for simultaneous operation of four hydrant



hose streams at  $0.95 \text{ m}^3/\text{min}$  (250 gpm) each for a period of four hours.

4. Domestic/process water requirements supplied by the fire distribution system (see Item 4 under heading "Water Supply Capacity") are  $0.57 \text{ m}^3/\text{min}$  (150 gpm) during the operation of the systems described in 1. or 2., and 3. above.

Capacity Calculation (for conditions assumed above).

1. Water volume required for 1. above:  $3.03 \text{ m}^3/\text{min} \times 15 \text{ min} = 45.4 \text{ m}^3$  (12,000 gal).
2. Water volume required for 2. above:  $2.84 \text{ m}^3/\text{min} \times 90 = 255.6 \text{ m}^3$  (67,500 gal).
3. Water volume required for 3. above:  $(0.95 \times 4) \text{ m}^3/\text{min} \times 240 \text{ min} = 912 \text{ m}^3$  (240,000 gal).
4. Total volume required for fire fighting:  $255.6 + 912 = 1,167.6 \text{ m}^3$  (308,000 gal) (use only the larger of Items 1. and 2. above - in this example, Item 2).
5. Water volume required for 4. above:  $0.57 \text{ m}^3/\text{min} \times 330 \text{ min} = 188 \text{ m}^3$  (49,500 gal) (duration corresponds to duration of Item 2. plus duration of Item 3).
6. Total water volume required: (Item 4. plus Item 5.) =  $1,167.6 + 188 = 1,355.6 \text{ m}^3$  (357,500 gal).

Site Distribution System

The design of the fire protection water distribution system should, as a minimum, conform with the requirements of NFPA Standard No. 24 (Ref 1).

The main distribution line should form a complete sectionalized loop through the facility or any large area within the facility, sized to provide the flows and pressures required, with flow from one direction only. In no case should the loop pipe size be smaller than 15.24 cm (6 in). In any arrangement where a main or branch of the main is dead-ended, it shall be increased to at least one size larger than the calculated size (to compensate for the likelihood of greater sedimentation and incrustation in a dead-ended main). Wherever possible, the main distribution loop should be supplied from two independent water



sources, each of which can provide the required flow rate, flow pressure and flow duration.

#### Protection Against Effect of Line Rupture

Wherever a branch supply from the main fire line enters a building, ramp or other facility where the possibility of explosion exists, provision should be made to minimize the loss of main pressure due to the rupture of the supply line in or adjacent to the area of the explosion. A method to accomplish such pressure loss limitation is described below:

A rate-of-flow device should be installed in the water supply line to the facility upstream of any part of the line subject to such rupture. The device should be adjustable, and should be set to limit the flow through the line to a maximum of 120 to 130 percent of the calculated flow required for the extinguishing system involved. The device must be such that any operational failure will cause it to go to its fully open position. In the event of a complete rupture of the downstream line, this device will limit the flow through the open end to the pre-set value, thereby preventing the severe pressure drop in the main which could be caused by flow through the open end of the ruptured line.

The rate-of-flow device should be located exterior to and at a sufficient distance from the structure it serves to insure its protection. When installed underground, it should be enclosed in a pit (pit shall be frostproof when required by climatic conditions). A manual shut-off valve of an indicating type (such as an outside stem and yoke or post indicator valve), sealed or locked in the open position, should be provided upstream of the rate-of-flow device to permit maintenance, and a test connection should be installed downstream which will allow periodic testing of the device's performance at its full rated flow. Provisions should be made for the safe disposal of the water discharged during testing.

Further discussion of rate-of-flow devices and examples of their use are included in this report in the section entitled "Hardened Water Curtains", while Appendix C contains examples of available rate-of-flow devices.



## EXTINGUISHING SYSTEMS

### General

This section presents an overview of the various types of fire extinguishing systems with a brief description of their operation, and general criteria to assist in the selection of the type best suited for a particular application. Adaptations of some of these basic systems for special hazards, and other specialized extinguishing systems are described in the sections of this report titled "Systems for Special Hazards" and "Hardened Systems".

The standards listed below and/or referred to in this section shall be considered to be minimum requirements as general criteria for the design of standpipe systems, fire extinguisher installations, and various types of installed extinguishing systems. Specific criteria or directives for particular applications will take precedence over any criteria included in this section.

#### A. National Fire Codes (Ref 1):

1. Standard No. 13 - Sprinkler Systems
2. Standard No. 15 - Water Spray Fixed Systems
3. Standard No. 16 - Foam-Water Sprinkler and Spray Systems
4. Standard No. 12A - Halon 1301 Systems
5. Standard No. 12 - Carbon Dioxide Systems
6. Standard No. 14 - Standpipe and Hose Systems
7. Standard No. 10 - Portable Fire Extinguisher

#### B. AMCR 385-100, Chapter 12 (Ref 6).

#### C. TM 5-812-1, Sections 5, 6 and 7 (Ref 2).

Underwriters' Laboratories, Inc., (UL) annually publishes a Fire Protection Equipment List (Ref 9), which includes devices, materials and equipment approved by UL for various types of fire extinguishing systems, with manufacturers' names and addresses.



The Factory Mutual System, (FM) annually publishes an Approval Guide (Ref 10), which is similar to the Underwriters' Laboratories' Fire Protection Equipment List. This guide includes devices, materials and equipment approved by Factory Mutual System for fire extinguishing systems.

Materials, devices and equipment to be used in any fire extinguishing installations should be limited to those listed in the UL Fire Protection Equipment List and/or the FM Approval Guide, except where the item is in a category not covered in these publications.

### Automatic Sprinkler Systems

#### Wet-Pipe Systems

Wet-pipe systems are used where there is no danger of water freezing in the pipes in the protected area or other parts of the distribution systems, and there are no special conditions which would require other types of systems. In this type of system, water under supply system pressure is released when the fusible link on a sprinkler head(s) in the vicinity of a fire reaches its melting temperature.

Where a small portion of an area (involving 20 sprinklers or less) protected by a wet-pipe system may be subjected to freezing temperatures, that part of the piping system can be filled with an antifreeze solution. Provisions must be made to prevent contamination of the domestic water supply, where applicable, and for testing and maintaining the required concentration of antifreeze, and refilling the system with antifreeze after operation or leakage.

Some typical applications for wet-pipe sprinkler systems in both administrative and manufacturing areas in munitions facilities are:

1. Office and toilet areas.
2. Inert material storage areas.
3. Bag making areas (bags for propellant charges).
4. Maintenance areas.
5. Building protection where hazardous operations have special protection systems.



### Dry-Pipe Systems

Dry-pipe systems are used in areas subject to freezing temperatures. In a dry-pipe system, the piping network downstream from a dry-pipe valve contains air (or inert gas) under pressure. When a fire opens a sprinkler, the resulting loss in pressure opens the dry-pipe valve, allowing water to flow to the opened sprinkler. Since there is a delay caused by the travel of the water from the dry-pipe valve to the open sprinkler, a dry-pipe system should be limited to a total piping system capacity of  $2.84 \text{ m}^3$  (750 gal) for each dry-pipe valve.

Dry-pipe valves are designed so that a given air pressure in the piping system will hold back a higher water pressure under the valve clapper. Dry-pipe valves are available with differential pressures (water to air) in the ranges of 5 or 6 to 1 (ordinary differential) and 1.0 or 1.2 to 1 (low differential). The low differential type is generally used only where there might be a problem with debris entering the system as a result of the carrying force of water at the higher velocities associated with operation of ordinary differential dry-pipe valves. To decrease the possibility of accidental tripping, air pressure in the system is usually maintained at 103.4 to 137.9 kPa (15 to 20 psi) higher than the tripping pressure. Most manufacturers of dry-pipe valves have available quick-opening devices (called accelerators or exhausters) that may be used in conjunction with their valves to shorten the response time of the dry-pipe system. These devices sense the rate of drop in air pressure characteristic of a single opened sprinkler, and either trip the valve before the air pressure has dropped to the trip level, or open an auxiliary valve to allow the air to escape at a more rapid rate.

Because of the slower response time as compared with a wet-pipe system, dry-pipe systems should be considered only where freezing is a possibility. Dry-pipe systems would be used in the same type of applications where wet-pipe systems are used and there is danger of freezing.

### Pre-Action Systems

Pre-action systems are basically the same as dry-pipe systems, except that the water control valve is opened by the operation of a fire detection system independently of the fusing of a sprinkler. Since the response time of fire detectors is more rapid than that of sprinklers, water is



available at the site of the fire sooner than it would be with an ordinary dry-pipe system. It is also common practice to maintain a low air pressure in the dry section of the piping system, designed so that a small pressure drop due to air leakage will provide a trouble signal. A pre-action system should be limited to a maximum of 1,000 sprinklers supplied by one pre-action valve.

Pre-action systems may be used for applications where dry-pipe systems are required, but quicker response times are needed, for example, in a long, unheated ramp. They are also suitable where it is especially important to avoid damage from water due to leakage or breakage of the piping system or sprinklers.

Under very special conditions, a pre-action system may be designed with a built-in delay between detector actuation and opening of the water control valve. This arrangement permits an operator time to abort the operation at his discretion if he can determine that there has been a false signal, or the circumstances are such that the application of water is undesirable.

#### Deluge Systems

A deluge system is essentially the same as a pre-action system, except that the sprinklers or nozzles are of the open type. When the water control valve is opened by the fire detection system, water flows through all the sprinklers or nozzles in the system.

Water control valves for deluge systems may be electrically, pneumatically or hydraulically operated or may be released by an explosive device.

Deluge systems are used when rapid propagation of a fire can be expected because of the nature of the materials involved, or where the configuration of the structure is such that heat from a fire may be deflected by drafts and, therefore, might not actuate ordinary closed sprinklers located above the site of the fire.

Deluge systems as applied in munitions facilities are generally of the ultra high-speed type discussed in the section titled "Systems for Special Hazards". Standard deluge systems in munitions facilities are most commonly used in areas such as paint spray and paint storage areas.



### Water Spray Fixed Systems

Water spray fixed systems are essentially similar to deluge systems, but use specialized types of nozzles in order to obtain spray patterns to suit the particular area or surface being protected. These systems are used mainly for the protection of flammable fluid tankage and piping systems, and electrical equipment such as transformers, oil switches and rotating electrical machinery.

### Foam Water Sprinkler and Spray Systems

Foam water sprinkler and spray systems are essentially similar to water sprinkler or spray systems in design, with the added capability of introducing a foam-forming concentrate into the water supplied to the distribution piping of the system. Foam has been found to be superior to water for extinguishment of fires involving flammable or combustible fluids.

The foam concentrate is added to the water in a pre-determined concentrate-to-water ratio by the use of balanced pressure proportioning systems incorporating foam concentrate pumps, pressure control valves, Venturi-type controllers and/or pressure tanks. As the mixture of water and foam concentrate is discharged from the sprinkler head or nozzle, air mixes with the solution to form foam.

### Design Requirements

Design requirements for the various types of automatic sprinkler and spray systems described above are covered in NFPA Standards Nos. 13, 15, 16 (Ref 1) and AMCR 3P5-100 (Ref 6). Except as previously qualified in this section, these requirements should be conformed to in the design of such systems for munitions facilities.

In general, with the possible exception of small areas involving light hazard occupancy, the piping systems required for a sprinkler installation should be sized based on the hydraulic design methods prescribed in NFPA Standard No. 13 (Ref 1) rather than on the pipe schedules shown in the same publication. Hydraulic design will result in more uniform water application rates over the protected areas, more efficient use of the available water supply, and in many instances, will prove to be more economical.



## Halon Systems

Halogenated fire extinguishing agents are hydrocarbon compounds in which hydrogen atoms have been replaced by halogen atoms, resulting in compounds which are non-flammable (as opposed to the hydrocarbons from which they derive) and have flame extinguishing characteristics. The reason for the effectiveness of halogenated agents in fire extinguishment is not completely understood. Their effectiveness is greater than could be expected on the basis of smothering and heat removal only; it is surmised that they chemically inhibit the combustion process in some way.

The halogenated agent in most common use in fixed extinguishing systems is Halon 1301 (bromotrifluoromethane,  $\text{BrCF}_3$ ). This compound has relatively low toxic effects on humans and insignificant corrosive effects on commonly used construction metals, and since it generally vaporizes rapidly in a fire, it does not present any important clean-up problems.

Halon 1301 may be employed in a local application system (discharging directly on the burning material) or, if the hazard is in an enclosed space, in a total flooding system (where the enclosure can be filled with the required Halon concentration).

Total flooding systems may be of the piped type, with Halon storage units located near the protected areas, or the modular type, where one or more storage units are located within the protected area and discharge directly into the involved space without any additional piping. In both types of systems, release of the Halon is effected by actuation of a fire detection system (see section on detection systems). See Appendix C for representative available Halon systems.

Halon is not suitable for use on propellants, explosives or other materials which contain their own oxidizing agent. Because of its inherent cleanliness as an extinguishing agent, total flooding Halon systems may be used for the protection of computer rooms and motor control centers in munitions facilities.

Compared with total flooding carbon dioxide systems for these applications, Halon systems generally would have a lower initial cost (but a higher recharging cost), and can be expected to be somewhat less effective against deep-seated fires due to the lower concentrations of Halon required by



NFPA Standards as related to the concentrations of carbon dioxide required by these standards.

Design requirements and general information for Halon 1301 systems are covered in NFPA Standard No. 12A (Ref 1). Except as previously qualified in this section, these requirements should be conformed to in the design of such systems for munitions facilities.

#### Carbon Dioxide Systems

Carbon dioxide extinguishing systems are used mainly for protection against flammable liquid fires and fires in electrical equipment, and have the advantages of requiring no clean-up operations and of doing little, if any, damage to equipment. Such systems are of either the local application type (where the surface of a flammable liquid is covered with carbon dioxide discharge for a long enough time to assure extinguishment of the fire) or the total flooding type (where an enclosure is flooded with enough carbon dioxide to create and maintain an inert atmosphere until extinguishment is completed). Carbon dioxide systems may be actuated manually or automatically by a fire detection system (see section on detection systems).

Carbon dioxide is not a suitable agent for extinguishment of fires involving propellants, explosives or other materials which contain their own oxidizing agents. Total flooding carbon dioxide systems may be used as an alternative to Halon for the protection of motor control centers and computer rooms in munitions facilities. See discussion of Halon systems for comparison of these systems.

Design requirements for and general information on carbon dioxide systems are covered in NFPA Standard No. 12 (Ref 1). Except as previously qualified in this section, these requirements should be conformed to in the design of such systems for munitions facilities.

#### Standpipe and Hose Systems

Standpipe and hose systems are a method of making fire extinguishing water readily available within a building for manual application by building occupants or Fire Department personnel. Such a system consists basically of a water distribution system inside the building, supplied from a reliable water source, with hose stations strategically located throughout the building. Hose stations for use by



building occupants are generally limited to 30.5 m (100 feet) of 3.81-cm (1-1/2-in) hose. Hose stations for use by trained personnel would have connections for 6.35-cm (2-1/2-in) hose, and may also be provided with an easily removable adapter for 3.81-cm (1-1/2-in) hose to be used by building personnel before the Fire Department arrives.

In munitions facilities, standpipe and hose systems may be used in administrative, inert material warehouse, and maintenance buildings as a supplement to or, less preferably, in place of, ordinary sprinkler systems.

Design requirements for and general information on standpipe and hose systems are covered in NFPA Standard No. 14 (Ref 1). Except as previously qualified in this section, these requirements should be conformed to in the design of such systems for munitions facilities.

#### Portable Fire Extinguishers

Portable fire extinguishers are primarily suitable for use where the possibility exists of discovering a fire in its earliest stages, and provide a relatively inexpensive first line of defense. Extinguishers are available in varying sizes using water, carbon dioxide, Halon 1211, Halon 1301, or various dry chemicals as extinguishing agents. Selection of size and type of units, and their distribution in the areas involved should take into account (1) the types of hazards involved, (2) the type of personnel likely to be using them, (3) the physical environment, (4) health and operational safety considerations. Carefully selected portable extinguishers may be used in any building or area in munitions facilities not protected by an ultra high-speed extinguishing system and where the timely use of such an extinguisher could prevent the spread of a small fire.

Guidelines for selection and distribution of portable fire extinguishers are covered in NFPA Standard No. 10 (Ref 1) and AMCR 385-100 (Ref 6).



## DETECTION SYSTEMS

### General

This section presents an overview of the various types of fire detection systems, with a brief description of their operation and general criteria to assist in the selection of the type of system best suited for a particular application.

Standard No. 72E (Ref 1) covers minimum performance, location, mounting, testing and maintenance requirements for automatic fire detectors. The design of automatic fire detection systems should, as a minimum, conform with the latest edition of this standard. To the extent possible, materials, equipment and devices incorporated in these systems should be items listed in either the UL Fire Protection Equipment List (Ref 9) or the FM Approval Guide (Ref 10).

It is very important that great care be exercised in the selection of the type of detector to be used, and its sensitivity adjustment, in order to minimize the occurrence of false alarm signals and/or false discharge without sacrificing the prompt detection of an actual fire condition.

### Detection Devices

#### Heat Detectors

##### Fixed Temperature Detectors

Fixed temperature detectors are suitable in areas where violent temperature fluctuations usually exist, but temperatures do not exceed a normal fixed level. This detector functions well with a slow, smoldering fire where the ambient temperature may not rise rapidly enough to activate a rate-of-rise detector. The fixed temperature detector sensing elements may be either (1) bimetallic, (2) electrical conductivity, (3) fusible alloy, (4) heat-sensitive cable or (5) liquid expansion.

##### Rate-of-Rise Heat Detectors

Rate-of-rise heat detectors are suitable in areas where normal temperature fluctuations exist. When a fire occurs, the sensing element responds immediately if the rise in temperature exceeds a minimum pre-established rate. Rate-of-rise heat detector sensing elements may be (1)



pneumatic tubing, (2) pneumatic spot-type or (3) thermo-electric effect.

#### Combination of Rate-of-Rise and Fixed Temperature Detectors (Rate Compensation Detectors)

These detectors utilize two distinctly independent elements to detect fire by rate-of-rise and fixed temperature. The advantage of this dual-element type of detector is that one detector can cover a much larger area than the single element detectors described previously. It is possible to obtain the dual-type detector with a visual indicator which automatically determines and indicates which of the two elements has been activated.

Requirements for heat detectors are given in Chapter 3 of Standard No. 72E (Ref 1).

#### Smoke Detectors

##### Ionization-Type Smoke Detectors

These detectors operate on the principle of detecting ionized particles of air resulting from the presence of smoke particles. This is accomplished long before visible smoke or heat is produced in sufficient quantities to actuate conventional fire detectors, and thus this type of detector will sound an alarm and/or actuate fire protection equipment sooner than other types of detectors. As the detector operates, an alarm-indicating light will come up and electrically lock in. The detector relay must then be reset to restore it to operational condition.

Ionization detectors are extremely sensitive and generally should not be used in spaces where high ambient concentrations of combustion products may be expected, as for example, manufacturing areas involving welding or other combustion-producing equipment, or in garages. Care must be taken in locating and adjusting the unit so as not to cause unnecessary false alarms.

##### Photo-Electric Smoke Detectors

These detectors are intended primarily for use in areas where it is not practical to use the ionization type due to a normal high ambient level of combustion gases. Photo-electric detection should not be used where there may be normally high levels of dust or other particulates in the air, which might cause false signals. It operates on the principle of



utilizing smoke to obstruct and reflect a standard light source into a photo-electric cell. The photo cell will operate a relay to sound an alarm, and the relay must subsequently be reset to restore it to operational condition. This type of smoke detection element is generally combined into a single unit with a fixed temperature detection element acting as a backup, providing the capability of early detection of either a smoldering low temperature type of ignition, or an ignition producing high early heat. Requirements for smoke detectors are given in Chapter 4 of Standard No. 72E (Ref 1).

### Flame Detectors

#### Infra-Red Detectors

These detectors instantly sense infra-red radiation emanating from flames. They are intended for use in areas of quickly developing fires where ignition is almost instantaneous, in high-ceiling areas and in high-air-movement areas. The sensitivity of this type of detector can be selected for a pre-determined time of sustained flame flickering to prevent undesired false alarms.

#### Ultra-Violet Detectors

These detectors will "see" the ultra-violet radiation emitted from all types of flames and yet are completely insensitive to visible and infra-red radiation and unresponsive to temperature, sunlight and other common sources of illumination. This unit is essentially a high-gain electronic tube which permits current to flow between anode and cathode only when ultra-violet radiation of sufficient intensity is present, and operates an alarm relay. When radiation is no longer present, the relay resets itself. Ultra-violet detectors are sensitive to gamma radiation, x-rays and arc-welding emissions. Where such sources may be encountered and ultra-violet detectors are otherwise desirable, the detector manufacturer's recommendations should be followed as to location, aiming and adjustment of the units to minimize the possibility of false alarms.

Requirements for flame detectors are given in Chapter 5 of Standard No. 72E (Ref 1).



## Combined Detectors

### Combined Smoke and Heat Detector System (Beam Master)

This system uses the principle of a laser beam to combine both smoke and heat detection. It consists of two units, a pulse transmitter emitting infra-red rays, and a photo-sensitive receiver positioned at a maximum range of 100 meters. When the pulsating beam is attenuated by smoke, or the air's refractive index is changed by rising heat waves, relays are activated to sound alarms and/or operate equipment. The advantage of this type of detector is that one unit can protect an area equivalent to 12 smoke detectors or 24 heat detectors at their maximum coverage, and is particularly suitable for protecting areas with ceiling heights of 4.25 m (14 ft) or more where air currents could delay actuation of conventional smoke or heat detectors.

## Control and Alarm Panels

### Smoke and Fire-Indicating Panels

These panels come complete with indicating lights for power on, fire, trouble lights, and a built-in trouble buzzer. Relays are also provided for any necessary action, such as operating extinguishing systems, closing fire doors, shutting off fans, operating dampers, shutting down conveyors, etc., instantly and automatically. There is virtually no limit to the number of detectors that can be connected to one panel.

### Zone Panels

These panels are used when it is desired to divide the protected area into sections or zones. A single panel can cover four zones, provide visual indication of the zone affected, and contain relays for the operation of fire-extinguishing equipment in the affected zone. Several zone panels can be connected to one control panel.

### Remote Annunciator Panels

These panels can be installed at a central location, such as at a master control room, and can give duplicate indication of all signals appearing on the zone and control panels. An internal buzzer is provided to alert the operator in case of trouble.



### Telephone Alarm Signals

Telephone alarm signals can be sent over telephone lines to the local Fire Department or to a fire dispatcher. This can be done by utilizing contacts on any of the three types of panels indicated above.

### Available Equipment

Some representative examples of available detection system components are contained in the Appendices A and B.



## POWER SUPPLY

### General

This section presents a summary of the special requirements for the electrical supply feeding systems and components of systems involved in fire detection, alarm and control.

### Emergency Power Supply

All equipment required for fighting and controlling fires, such as fire pumps, motor-operated valves, sprinkler systems, door releases, fire detection and alarm equipment, damper operators, fan shut-off relays, etc., should be fed from an emergency power bus. This bus is normally fed from the utility or facility power feeders. On loss of normal power, an emergency generator, usually diesel-driven, will be automatically started and energize the emergency bus through an automatic transfer scheme.

### Battery Pack

The fire detection system, including feeders to control, zone-indicating and annunciator panels, in addition to being fed from the emergency bus described above, should be provided with a battery pack. The battery pack installation should include a built-in transfer device and charger, and should provide power for the fire detection system for 24 to 48 hours. The battery pack system should automatically take over on failure of both normal and emergency power, and cut out on restoration of power.

### Intrinsically Safe Systems

Electrical equipment should generally be located in areas having the lowest possible hazard classification (see National Electrical Code, Article 500 for classification). When it is necessary to locate equipment in areas where flammable gases or vapors may be present (Class 1 locations), "intrinsically safe" design principles should be applied in planning the electrical system.

This approach requires that the electrical system be incapable of releasing electrical or thermal energy in amounts sufficient to cause ignition or initiate combustion at any time. This can be accomplished by applying the following guidelines:



1. All equipment, conduit systems and wiring devices must be specified as approved for use (in accordance with NEC Article 500) in an area with the particular hazard classification).
2. The area so classified must be completely isolated by the use of seals in accordance with NEC requirements.
3. System voltage levels should be as low as possible and should not exceed 24 volts.
4. Required energy-limiting components must be located outside the hazardous area.
5. Battery-operated apparatus must have the battery and energy-limiting components located outside the hazardous environment, and be so constructed that a direct short circuit of the battery is virtually impossible.



## SYSTEMS FOR SPECIAL HAZARDS

### General

This section contains recommended fire extinguishing systems and components that are suitable for various special hazards associated with Load, Assemble and Pack (LAP) facilities, with brief descriptions of their operation and general criteria to assist in selection of the type of system best suited for a particular application.

As far as they are applicable to these special systems, NFPA Standards referred to in sections of this guide covering Site Water Supply, Extinguishing Systems, Alarm and Detection Systems, and Power Supply should be conformed to in system design. To the extent possible, all materials, equipment and devices incorporated in these systems should be items listed in either the UL Fire Protection Equipment List (Ref 9) or the FM Approval Guide (Ref 10).

### Ultra High-Speed Deluge Systems

Ultra high-speed deluge systems generally utilize either an infra-red or ultra-violet detector system which will respond within several milliseconds following surface ignition within the detectors' field of coverage, and initiate water flow in the deluge system by actuating the deluge valve. An ultra high-speed deluge system can be assembled using components from various manufacturers, or it can be a completely engineered system furnished and installed by a fire protection equipment manufacturer.

#### "Primac" System (Grinnell Corporation)

An example of an acceptable engineered ultra high-speed fire protection system is Grinnell's "Primac" system. The basic components of this system are: one or more photo-conductive detection units; a transistorized amplifier; a water control (deluge) valve actuated explosively; deluge discharge nozzles; and supervisory and test devices.

When the detection system senses the presence of radiant energy of an intensity and wavelength range associated with the initial ignition point, it sends an amplified electrical signal which detonates the primer in the control valve. The primer explosion releases a latch, allowing the water supply line pressure to open the valve thus raising the priming water



in the nozzle supply piping to line pressure. The line pressure blows off the nozzle cap (or bursts the rupture discs) which had retained primary water in the piping.

The total operation time for this system consists of two phases. The first phase is the time from detection of fire to firing of the primer, and for the "Primac" system, is on the order of 2 to 3 milliseconds in length. The second phase is the time between the firing of the primer and the start of flow from the nozzles, a time period subject to considerable variation. Some of the factors that affect this "second phase" time are: (a) the amount of entrapped air in the primed piping system downstream of the control valve (Grinnell tests have indicated that air pockets totalling only about 5 percent of the system volume will approximately double the operating time), (b) water supply pressure (delivery time is proportional to the square root of the pressure), (c) the length and configuration of the system piping between the control valve and the nozzles (the shorter and more direct the piping, the quicker the delivery time).

Because of the variables involved in the "second phase" time, the complete operation time for "Primac" systems may show considerable variation, but when the system has been properly designed, installed and tested, the total operation time will usually be between 20 and 200 milliseconds.

#### "Pilotex" System (Automatic Sprinkler Corporation of America)

Automatic Sprinkler Corporation's "Pilotex" is another acceptable engineered ultra high-speed deluge system. In this system, the spray heads (called "Auto-Spray") are pilot-operated nozzles that are kept closed against supply line pressure by water pressure in a pilot line. This pilot system is normally connected to the fire main as a source of pressure. The differential in water pressure actuating surface areas (pilot line water pressure versus main supply line pressure) maintains the "Auto-Spray" head in the closed position. The fire detection system may utilize any of the detectors available (see section on Alarm and Detection Systems), but for ultra high-speed applications, infra-red or ultra-violet detectors would be used to obtain rapid actuation of the release system. The detection system opens a solenoid-operated relief valve, dropping the pilot line pressure and allowing fire main line pressure to open all the nozzles connected to the pilot system. The pilot line size restriction is small enough to prevent the pilot pressure from being maintained with the relief valve in the open position.



When properly designed, installed and tested, the "Pilotex" system is capable of delivering water from the nozzles in as little as 50 milliseconds after detection of ignition.

On "Pilotex" installations, it is recommended that the pilot nozzles be provided with male threads on the outlet side permitting attachment of lengths of hose to facilitate periodic flow testing. These flow tests will reduce the possibility of accumulated deposits between the poppet and the body interfering with operation of the pilot nozzle.

#### Rupture Disc Deluge Valves

Both the "Primac" and "Pilotex" systems ultimately depend on movement of mechanical devices to permit water to flow; in one case, a latched plug (in the Grinnell "Primac" control valve), and in the other ("Pilotex" system), a solenoid relief valve on the pilot line and a poppet at each nozzle. Deluge valves using detonator-actuated rupture discs are available in a wide range of sizes. When used in conjunction with ultra-violet or infra-red flame detectors, transistorized control panels and a properly designed and installed system of water piping and nozzles, such equipment is capable of total response time of the same order of magnitude as can be obtained with the "Primac" and "Pilotex" systems. Total response time will depend on whether ignition takes place on or beneath the surface of the hazardous material, the reaction time of the detection system, the actuation time of the deluge valve following the signal from the detection system, the distance the water must travel to the nozzles, and the configuration of the piping system.

#### Applications in Munition Manufacturing Facilities

Ultra high-speed deluge systems should be provided at each station where operations are performed involving high hazard materials such as boosting explosives (e.g., PETN, tetryl and RDX), bursting charge explosives (e.g., amatol, Explosive D, DBX, picratol, picric acid, RDX compositions, TNT and tritonal), solid propellants, black powder and HC smoke mixture.

Examples of the types of operations that should be provided with ultra high-speed deluge systems are: weigh feeding stations, mixing and blending stations, screening stations, press and pelletizer stations, melt units, combined bag loading and sewing operations, powder loading stations and drying ovens.



Where operations are carried out involving initiating explosives (e.g., lead azide, lead styphnate, mercury fulminate, tetracene) which will detonate on ignition, fire extinguishment at the operating station is not feasible, but the use of deluge systems in adjacent areas should be considered to prevent the spread of fire to the sensitive materials.

#### Design Requirements for Deluge Systems at High Hazard Work Stations

##### Flame Detectors

Ultra-violet flame detectors have been found through testing and use experience to be preferable to infra-red sensors for rapid and reliable response to initial flaming, and should be used as the detection device for ultra high-speed deluge systems installed at work stations in munitions facilities. In these installations, as many detectors should be provided as are required to assure that the total area of the work station is within the effective field of coverage of at least one detector.

##### Nozzles

Nozzles should have a full cone spray pattern and should be located as close as possible to the exposed surface of the explosive material. As many nozzles should be used as are necessary to provide a minimum water application density of  $0.12\text{m}^3/\text{min}/\text{m}^2$  (3 gpm/ft<sup>2</sup>) over the involved area.

All nozzles should have rupture discs or dust caps which will be readily released by water pressure. The cap should be secured to its nozzle by a small non-ferrous chain to prevent its loss after release.

##### Deluge Valve

The water control (deluge) valve should be located as close as possible to the nozzle(s) to minimize the overall response time, and should be arranged to permit manual as well as automatic actuation.



## HARDENED WATER CURTAINS

### General

This section covers criteria for a ramp fire protection system intended to prevent the spread of fire from one building to another through a connecting ramp. Such system, called a "hardened water curtain", is intended for installation in the portion of the ramp adjacent to the building. The system is designed to withstand the effects of blast and fragmentation associated with an explosion in the material being conveyed through the ramp and extinguish the resulting fire. Included at the end of this section is a brief discussion of the use of firebreaks in ramps where hardened water curtains or other automatic extinguishing systems are not provided.

Tests conducted by Southwest Research Institute (Ref 11) indicate that the systems described in this section can survive the detonation of 27.3 kg (60 lb) of Composition B contained in a box on a roller conveyor, or loose Composition B on a Serpentix conveyor, and extinguish the resulting fire within approximately 1/2 minute after detection with recovery of measurable amounts of the explosive material unburned.

In addition, this same test program indicated that with suitable shielding of exposed parts, such systems will survive the explosion of sixteen 105-mm projectiles on a wheeled conveyor cart and extinguish resulting fires.

The terminology "water curtain" or "water curtain module" as used in this section means a system of piping and nozzles which will deliver directed sprays of water over a 15.2-m (50-ft) length of the connecting ramp measured outward from the ramp's plane of entrance to the building.

The hardened system is comprised of a hardened water curtain, special valving, and a fire detection system, all as described in the following.

### Hardened Water Curtain

A hardened water curtain module (Fig 1 and Fig 2) is defined as a water delivery system which consists of three major component parts: (1) uprisers with attached spray nozzles; (2) a water supply piping system with drain and, where needed, refill systems; and (3) control valving. Each module is hydraulically designed in accordance with its specific application and the



water pressure available in the main facility water loop (hereafter referred to as the main water loop). Figure 1 and Figure 2 show examples of water curtain modules where the water deluge, operating in the conveyor ramps, is capable of putting out a fire resulting from an explosion of the conveyed material.

### Uprisers

An upriser (Fig 3) is the terminus of the water curtain piping with attached nozzles through which the water deluge is delivered. A minimum of five uprisers are suggested for each module, located on 3.8-m (12.5-ft) centers along one side of the ramp, with every part of the protected area receiving water spray coverage from at least two nozzles. One or two nozzles are located at the top of each upriser on a "tree" consisting of one elbow and two street elbows (for an upriser with one nozzle), or one pipe tee and four street elbows (for an upriser with two nozzles).

### Nozzles

The nozzles to be used should be full cone spray type with rupture disc or blow-off cap which will be readily released by water pressure. The nozzles should be selected for flow rate and spray angle to provide a minimum water application rate over the protected area of  $0.024 \text{ m}^3/\text{min}/\text{m}^2$  ( $0.6 \text{ gpm}/\text{ft}^2$ ), with all nozzles operational. See Appendix C for representative available nozzles.

### Piping System

Piping uprisers and the supply lines (Fig 3) should be Schedule 40 or heavier steel pipe. The supply line should have welded connections. To insure that the supply line is not damaged by blast or fragments, it should be buried in the ground adjacent to the ramp. Individual uprisers would penetrate the walls of the ramp so that the nozzles are exposed to the ramp interior. Piping for the hardened water curtain may be supplied by either a wet- or dry-pipe module depending upon the required response time. A wet-pipe arrangement is inherently faster as no time is lost in filling the piping system. When a wet-pipe system is utilized, water located within the curtain loop is not under pressure since it is located downstream from a rupture disc valve (which is discussed later). The dry system is similar except that the pipelines downstream from the rupture disc valve are empty.



### Shielding

If the ramp is used to convey loaded projectiles, 2.54-cm (1-in) thick steel plates should be provided to protect the uprisers and nozzles from high velocity fragments, with minimum sized cut-outs provided after the nozzles have been aimed (Fig 4).

### Special Valving

Valving for hardened water curtains includes a rupture disc valve (also referred to as deluge valve) and a rate-of-flow device. The deluge valve is always used; whereas the rate-of-flow valve is only needed when there is a possibility that the water supply line to a building will be ruptured.

#### Rupture Disc Valve

Water to a hardened curtain is supplied through a rupture disc valve usually located in the building adjoining the ramp containing the water curtain. However, in certain cases, this valve may be installed in a pit (frost-proof, when required), adjoining the ramp.

The rupture disc valve is actuated by an electrical current produced by the fire detection system. This current actuates a detonator which ruptures a diaphragm permitting water flow into the water curtain loop. This flow will pressurize the water within the loop of the wet system, thereby causing it to be discharged at the nozzles. With the dry-pipe system, a time lapse will take place while the upstream water flows through the curtain loop before being discharged at the nozzles. If this time delay is acceptable, the dry system is the more desirable since the water within the curtain loop of the wet-pipe system must either be provided with antifreeze or heat-traced to prevent freezing in unheated ramps during the winter. Applicable rupture disc valves are shown in Appendix C.

#### Rate-of-Flow Device and Shut-Off Valve

A rate-of-flow device will limit the flow of water into a building in the event that the water supply system within and/or immediately adjoining the building is ruptured, and thus prevent a severe pressure drop in the main water loop. Each such device should be installed with a manual shut-off valve to permit maintenance of the device. A more detailed discussion of such devices and their application is presented in the section titled "Site Water Supply".



### Fire Detection System

The fire detection system used with each water curtain (Fig 5) is an unhardened system consisting of two ultraviolet detectors located in the ramp in the vicinity of the curtain. The control panel for the detection system is located within and protected by the adjoining building. A water curtain is actuated by an electrical current produced by the fire detection system. If water curtains are situated at opposite ends of a ramp, an electrical cross-connection is provided such that a fire at either end of the ramp will actuate both water curtains. The detection system should also be interlocked so that it will shut down the conveyor system in the ramp upon detection of fire or explosion. In applications where several ramps can be affected by a single occurrence, consideration should be given to providing cross-connections to simultaneously actuate the water curtains in all the involved ramps. Where this is done, the water supply must be sufficient for concurrent operation of all these water curtains.

### Protection Levels with Hardened Systems

The protection afforded by hardened systems consists of two elements.

The first of these is the protection provided for a particular building against the spread of fire caused by an incident in a ramp connected to the building, or by an incident in another building connected to this ramp. This protection is provided for by installation of a hardened water curtain in the connecting ramp where the ramp joins the building.

The second element is the protection afforded other buildings in the facility in the event that an explosion causes serious damage to the water supply for a particular building. This protection is provided for the other buildings by installing a rate-of-flow device in the exterior supply line to the particular building where such damage might occur. This device will limit the flow through the damaged line to a pre-determined rate, thereby limiting the reduction in pressure in the fire main and preserving the availability of water for the automatic fire extinguishing systems in the other buildings in the area.

The degree or level of protection afforded by a hardened system depends upon the location of the water supply to the system, and whether or not rate-of-flow devices are used. In defining the three protection levels below, the term "adjoining building" refers to the building immediately next to the water



curtain, while the term "nearby building" refers to any facility building other than the adjoining building.

#### Fire Protection Level I

Fire Protection Level I consists of a hardened system, with water for the water curtain module supplied from a water supply line located within the adjoining building. The rupture disc (deluge) valve is located inside this building.

Protection Level I is applicable when:

1. There is a low probability of damage to the water supply to or within the adjoining building due to an explosion in a nearby building; and
2. There is a low probability of such damage due to an explosion in the adjoining building; or
3. There is a high probability of such damage due to an explosion in the adjoining building, but the water supply for this building is already controlled by a rate-of-flow device.

#### Fire Protection Level II

Fire Protection Level II consists of a hardened system, with water for the water curtain module supplied from a water supply line located within the adjoining building, and a rate-of-flow device installed (in a pit) in the underground water supply line to this building. The rupture disc valve is located inside the building.

Protection Level II is applicable when there is a high probability of damage to the water supply to or within the adjoining building due to an explosion in this building.

#### Fire Protection Level III

Fire Protection Level III consists of a hardened system, with water for the water curtain module supplied directly from an exterior water supply main, and a rate-of-flow device installed (in a pit) in the underground supply line. The rupture disc device is located in a pit adjacent to the ramp.

Protection Level III is applicable when there is a high probability of damage to the water supply to or within the adjoining building due to an explosion in a nearby building.



### Selection of Protection Levels

Principles for choice of an appropriate level of protection (Levels I, II or III) must be applied to each building and ramp on an individual basis and are dependent upon the following factors:

1. The damage anticipated as a result of an incident, considering the amount of explosives involved and the structural design of the building or ramp.
2. The probability of an incident occurring.
3. The capital cost of the installation required for the level of protection chosen.

As an example of the reasoning involved in choosing appropriate protection levels, the procedures used in determining such levels for the 105-mm HE M1 Projectile Melt/Pour Facility at Lone Star AAP (Fig 6) are outlined in the balance of this section, and summarized in Table 1. Figures 7 through 15 are schematic representations of the recommended hardened water curtain installations for this facility, as well as some recommended locations of ultra high-speed deluge systems at work stations.

The first factor considered is the ability of particular buildings in this facility to withstand explosive incidents. Buildings E-125 and E-161 were structurally hardened in design to resist an explosion occurring in Building E-4, E-120 or E-123. Building E-138 was structurally hardened to resist an explosion in Building E-166 or E-167. Building E-120 was structurally hardened to resist an explosion in Building E-123, and Building E-123 was structurally hardened to resist an explosion in building 120.

The second factor considered is the probability of an incident actually occurring, and two sets of conditions are assumed, which are hereafter referred to as Application 1 and Application 2. For Application 1, a high potential for an explosion is assumed to exist only in Buildings E-4, E-120, E-123, E-125, E-161, E-166 and E-167, with an explosion in Building E-161 producing massive damage throughout the facility. For Application 2, a high potential for an explosion is assumed to exist in Buildings E-4, E-120, E-123, E-166 and E-167, with small possibility of an explosion occurring in either Building E-125 or E-161 (see Figs 16 and 17).



In the specific protection levels offered for Lone Star, those levels needed to provide the necessary protection corresponding to the probability of an incident occurring as specified by Application 1 above are described below. In the later description of Application 2, only those levels differing from corresponding situations of Application 1 are discussed.

Application 1 - Protection Level III (see Figs 17 and 18)

For Application 1, the probability of an explosion in either Building E-125 or E-161 is assumed.

In the event of an explosion in Building E-125, the damage inflicted on Building E-161 will be severe, with a strong possibility that either one or both of the water curtains in Ramp RE-25 as well as the water main in Building E-161 will rupture. These failures would substantially reduce the water pressure available in the main water loops for fighting fires at other locations. Therefore, Level III Protection is required for the water curtain in Ramp RE-25, with a direct connection from the exterior water main provided to insure its continued operation (Fig 8).

Level III Protection is also valid for the water curtain at the south end of Ramp RE-25. If an explosion (90,000 pounds) occurs in Building E-161, the damage sustained by Building E-125 will be extensive with a high probability of the water main in the building rupturing. To compensate for this possibility and be assured that the adjoining water curtain will function after the explosion, a direct water line is connected between the water curtain and the exterior water main servicing the building. Also, rate-of-flow and outside stem and yoke (O.S.&Y.) valves are provided in the exterior water main to prevent the uncontrolled flow of water after its rupture. These valves and a rupture disc valve are installed in frost-proof pits. The new water main connection to the water curtain at the ramp is buried (Fig 8).

Application 1 - Protection Level II (see Figs 17 and 19)

The water curtains located at the south end of Ramps RE-42 and RE-43 adjoining Buildings E-120 and E-123 require Level II Protection. If an explosion occurs in Building E-125, E-120 or E-123, its effects on either Melt/Pour Building (E-120 or E-123) serving as an acceptor will be minimal. Therefore, the water supply for each water curtain is delivered from the adjoining building interior, with the rupture disc valve located within the building (Figs 7 and 9). However, if the explosion occurs in one of the Melt/Pour Buildings, the water main to that building would



be ruptured, and hence, Buildings E-120 and E-123 each require the addition of a rate-of-flow valve to control the water discharge (Figs 7 and 10). It should be noted that the connections of Ramps RE-42 and RE-43 to the Melt/Pour Buildings are at the second story. The elevated ramp at one of these buildings will be damaged by the effects of a massive explosion in one of the above-mentioned buildings. This damage would more than likely be associated with damage to the hardened water curtains. Therefore, several hardened nozzles are designed to be located within each building in the vicinity of the ramp entrance. A separate water supply for these additional nozzles is furnished from the building interior. These nozzles, as well as the nozzles of the water curtain, are actuated by the fire detection system in the ramp.

An explosion in Building E-123 could be expected to severely damage Building E-126 with high probability of rupturing the water supply to E-126. Since this water supply is connected to the main servicing Building E-125, such rupture will diminish the available water at E-125. To reduce the effect of this rupture, a rate-of-flow device is inserted in the water main supplying Building E-126 (Figs 7 and 9). Similarly, an explosion in Building E-123 could affect the water supply to Building E-120 by damaging the supply to Building E-142, and an explosion in E-120 could affect the water supply to E-123 by damaging the supply to E-143. Rate-of-flow devices are therefore inserted in the water mains supplying Buildings E-142 and E-143.

Considering Ramp RE-31 at Building E-129, the possibility of an explosion in Building E-129 is extremely unlikely. However, since Building E-129 is separated from Buildings E-120 and E-123 by unbarricaded intraline distances (incident overpressure of 3.5 psi), an explosion in either of these latter buildings will produce considerable damage in the vicinity of the entrance to Building E-129. It may be expected that both Ramp RE-31 and Building E-162 will be severely damaged with a strong possibility that the water main supplying E-162 will be ruptured. Since this water main is also connected to the water main servicing Building E-129, the main rupture at the former building will diminish the water supply to Building E-129. To reduce the effect of such a rupture, a rate-of-flow device is inserted into the water main servicing Building E-162 (Figs 7 and 11). The flow of water to Building E-129 is assured by the rate-of-flow device, and following the guidelines set forth previously, the hardened water curtain could be connected to the water supply inside Building E-129. However, in this special case, since there is no building fire protection in Building E-129, and because of physical limitations, a separate connection must be made from the outside



underground main with the rupture disc valve located in a pit (Figs 7 and 11).

Application 1 - Protection Level 1 (see Fig 20)

Since a rate-of-flow device is furnished with the water curtain at the south end of Ramp RE-25, the hardened water curtains in Ramps RE-42, RE-43 and RE-44 at Building E-125 need only provide Level 1 Protection. If an explosion occurs in either Building E-120 or E-123, Building E-125 will completely survive with little or no effects of the explosion. Therefore, the source for the water supply to the curtains and the rupture disc valves are located within Building E-125 (Fig 9).

Ramp RE-3 has an existing unhardened sprinkler system. This system will be severely damaged by the effects of an explosion in Building E-4. Furthermore, since the ramp is constructed of wood, it is expected that a fire would spread from Building E-4 along this ramp to Building E-9. To provide protection for Building E-9, a rate-of-flow device is installed in the water main servicing the existing sprinkler system and a hardened water curtain is located at the end of Ramp RE-3 adjoining Building E-9 (Fig 7). Since Building E-9 is not expected to sustain severe damage from the explosion in Building E-4, Level I Protection is provided at this building. The water supply and the rupture disc valve for the hardened curtain are located within Building E-9.

Application 1 - Balance of Facility (see Fig 21)

An explosion occurring in either Building E-166 or E-167 will produce massive damage to surrounding unhardened ramps (RE-30, RE-31, RE-39 and RE-45) and buildings. It is expected that Buildings E-146, E-150, E-153, E-154, E-155 and E-165 will sustain very heavy damage. Damage to the adjoining earth-covered steel arch magazine will be minimal. The water lines servicing the unhardened buildings are expected to rupture. To protect the remainder of the facility and to insure an adequate water supply to fight the spread of fires, rate-of-flow valves are used to control the water flow through ruptured water mains (Figs 7 and 12). The use of hardened water curtains at this portion of the facility is not recommended. It has been shown that the damage in the vicinity of Buildings E-166 and E-167 will be heavy and possible electrical fire may result. However, safe separation tests have shown that when carriers of sixteen 105-mm projectiles whose explosives have solidified and whose funnels have been removed are spaced at 12.2-m (40-ft) intervals, there will be extremely low probability of propagation of fire. In addition, except for Building E-138, all buildings in the immediate



vicinity are unoccupied by operating personnel. In the case of Building E-138, the structure is separated from either of the hazardous structures by a distance greater than the Inhabited Building Distance (IBD), and designed to resist an explosion in either building.

Building E-4 is separated from Building E-120 by intraline distance. In the event of an explosion in the latter structure, Building E-4 will be subjected to relatively high overpressures (greater than 3 psi). Although the building is constructed of concrete, many openings (of frangible construction) exist that will permit blast pressure leakage into the structure. This, in turn, will cause considerable damage to the building's interior. The damage could cause interior fires which hardened fire protection systems at the ramp entrances (Ramps RE-2, RE-3, RE-15 and RE-47) to the building would have little effect in fighting. Therefore, the use of hardened water curtains at the ramp entrances to Building E-4 is not warranted. Building E-4, however, is still a potential donor structure. An explosion within this building would more than likely damage water mains within the structure and destroy portions of the adjoining ramps. Since Ramp RE-2 does have an unhardened fire protection system, a rate-of-flow valve is needed to control the water flow in the event of a rupture (Fig 7). Fires produced by an explosion in Building E-4 will more than likely spread along the ramp towards Building E-2. However, since the operations in this building involve metal parts only and do not contain explosives, propagation of explosion between these two structures cannot occur. The two water mains servicing Building E-4 will each require a rate-of-flow valve to control water flow in the event of a main rupture (Figs 7 and 13).

Both wooden Ramps RE-4 and RE-10 at Buildings E-9 and E-12 have existing unhardened fire protection systems. Since the probability of an explosion occurring in either of these buildings is extremely small and the ramps are separated by at least Inhabited Building Distances from those buildings having a high potential of an explosion occurrence, the unhardened systems may be expected to remain operable after an incident.

Fire protection systems are not required for Ramps RE-39 and R-E-W at Buildings E-12 and E-9, respectively, since (1) both structures are constructed of non-combustible material which will limit the spread of fire, (2) the explosive items transported through the ramps have a very low potential to enhance fire propagation, and (3) both buildings to which the ramps are attached are located at safe separation distances greater than Inhabited Building Distances from a potential explosion. In the



case of the latter, the strength of the buildings is more than sufficient to resist relatively low overpressures associated with IBD.

Application 2 - Reduction of Protection Level at Ramp RE-25  
from III to I (see Fig 17)

Since the actual probability of an explosion in either Building E-161 or E-125 (Hazard Category III Operations) is remote and these buildings have been structurally hardened against the effects of an explosion in Building E-4, E-120 or E-123, the probability of damage to their water mains is also remote. Hence, the water lines servicing the hardened water curtains at each end of Ramp RE-25 can be connected directly to the water supply in the respective adjoining buildings, which corresponds to Level I Protection. This reduced protection level, as compared to that required for Application 1, will permit the elimination of the rate-of-flow valves and associated shut-off valves, and buried piping that connects the two water curtains directly to the exterior water mains servicing the two adjoining buildings. Also, the rupture disc valves are relocated from the frost-proof pits to the building interiors. However, use of hardened water curtains is needed. Although an explosion in Building E-4, E-120 or E-123 would severely damage Ramp RE-25, the hardened water curtains will function as required to negate the spread between the buildings of fires resulting from electrical short-circuiting and the explosive dust in the air due to the blast dispersal of the Composition B flake (Figs 7, 14 and 15).

The remainder of Melt/Pour hardened fire protection systems for Application 2 will remain the same as described for Application 1.

Firebreaks in Ramps

Where an enclosed ramp between buildings is constructed of combustible material, and no automatic fire extinguishing system is installed, a firebreak should be provided near the midpoint of the ramp, to prevent fire from spreading from building to building along the ramp. The firebreak should consist of a non-combustible ramp section with a self-closing rated fire door at the center of its length. This non-combustible section should be at least 20 feet long, with a parapet at the roof above the fire door. The non-combustible section will impede the spread of fire, and the fire door will prevent the ramp from acting as a horizontal flue.



When the ramp in which the firebreak is to be installed contains a conveyor, the conveyor opening through the partition in which the fire door is located should be kept as small as possible consistent with operating requirements.

During layaway periods when no personnel are in the area and sprinklers may be shut down, the fire doors could be closed to provide a measure of protection against the spread of fire.

Consideration should also be given to the installation, in a non-combustible ramp, of rated fire doors at building entrances or in the middle of the ramp.

Where fire doors are installed in ramps, additional exits must be provided as required by AMCR 385-100 (Ref 6).



## ANALYSIS OF FIRE PROTECTION REQUIREMENTS

### General

Determination of the extent of the fire protection to be provided at a particular facility and selection of the type of system to be installed at specific buildings, ramps and work stations should, in general, follow the recommendations contained in TM5-812-1, Fire Prevention Manual (Ref 2), and the guidelines presented in earlier sections of this report. It is recognized, however, that economic considerations will often dictate the provision of other than the optimum degree of protection desirable. This section provides a brief overview of the use of guidelines relating to hazard probability and severity set forth in DRCPM-PBM Memorandum No. 385-3 (Ref 12) in determining the extent and type of fire protection to be provided.

### Hazard Probability

Hazard probability is defined as the likelihood, expressed in quantitative or qualitative terms, that a hazard will occur. The probability that a hazard will occur during the planned life expectancy of the system can be described in potential occurrences per unit of time, events, population, items, or activity. Assigning a quantitative hazard probability to a potential design or procedural hazard is generally not possible early in the design process. A qualitative hazard probability may be derived from research, analysis, and evaluation of historical safety data for similar systems. Supporting rationale for assigning a hazard probability is documented in hazard analysis reports. An example of a qualitative hazard probability ranking is shown below with relative need for fire protection indicated by letter under heading: "Level" in descending order.

#### Hazard Probability vs. Fire Protection Need

<u>Descriptive Words</u>	<u>Level</u>	<u>Specific Individual Item</u>	<u>Multiplicity of Items</u>
Frequent	A	Likely to occur frequently.	Continuously experienced.
Reasonably probable	B	Will occur several times in life of an item.	Will occur frequently.



<u>Descriptive Words</u>	<u>Level</u>	<u>Specific Individual Item</u>	<u>Multiplicity of Items</u>
Occasional	C	Likely to occur sometime in life of an item.	Will occur several times.
Remote	D	So unlikely, it can be assumed that this hazard will not be experienced.	Unlikely to occur but possible.
Extremely improbable	E	Probability of occurrence cannot be distinguished from zero.	So unlikely, it can be assumed that this hazard will not be experienced.
Impossible	F	Physically impossible to occur.	Physically impossible to occur.

#### Hazard Severity/Accident Categories

Hazard severity categories are classified by MIL-STD-882A (Ref 13) into four categories, I, II, III and IV (and subdivided into A or B to designate effect on equipment or personnel), based upon the most severe result of personnel error, procedural deficiencies, environment, design characteristic, or subsystem or component failure or malfunction. When the necessary conditions exist and the necessary sequence of events occur, then a hazard severity category becomes the corresponding category accident. The probability values given in hazard analyses indicate the probability of the transition occurring from hazard to accident. The hazard severity categories (and corresponding accident categories) are defined as follows:

1. Category I $\alpha$  (Catastrophic) - Failure mode occurrence will cause system loss or large scale environmental damage.
2. Category I $\beta$  (Catastrophic) - Failure mode occurrence will cause death or permanent total disability to one or more persons.



3. Category II $\alpha$  (Critical) - Failure mode occurrence will cause critical system damage or some environmental damage.
4. Category II $\beta$  (Critical) - Failure mode occurrence will cause permanent partial disability to one or more persons.
5. Category III $\alpha$  (Marginal) - Failure mode occurrence will cause minor system damage or some environmental damage.
6. Category III $\beta$  (Marginal) - Failure mode occurrence will cause temporary total disability or lost time injury not covered by Category IB or IIB.
7. Category IV (Negligible) - Failure mode occurrence will not result in injury, occupational illness or system damage.

The design goals for each accident category in a project will be no greater than the following mean probability values:

Accident Category	Accidents per Facility-hr	Accidents per man-hr
I $\alpha$	10 <sup>-6</sup>	-
I $\beta$	-	10 <sup>-7</sup>
II $\alpha$	10 <sup>-5</sup>	-
II $\beta$	-	*10 <sup>-6</sup>
III $\alpha$	10 <sup>-3</sup>	-
III $\beta$	-	*10 <sup>-6</sup>
IV	1	1

\*Note: The sum of the probabilities of Category II $\beta$  or III $\beta$  occurring shall be 10<sup>-6</sup> per manhour or lower.



### Analysis

Based upon the qualitative determination of hazard probability alluded to earlier in this section, and a preliminary evaluation of hazard severity/accident categories, an analysis should be made of the various operating stations, operations, systems and system components, and structures comprising the facility involved. With the above factors taken into consideration, priorities should be assigned to the elements of an idealized fire protection installation for the facility or facility portion in question, based upon the reduction in probability of injury to personnel or damage to systems or components. Once such priorities have been established, it remains only to determine estimated costs of the various systems for the complete fire protection installation, and provide for as many of these systems as is economically feasible.



## SYSTEM COSTING

### General

This section summarizes the various major items which should be considered in arriving at an estimate of cost for fire extinguishing systems. Particular emphasis is placed on the types of systems most suitable for use in ammunition plants.

### Site Water Supply and Distribution Systems

In estimating the cost of water supply and distribution systems for fire protection, the components to be considered, as applicable, include: wells and well pumps; ground level and elevated storage tanks; fire pumps, drivers and controllers; electric power, fuel systems and enclosures for pumps (heated where required); pipe, valves and fittings for pump and tank installations and distribution systems, including necessary excavation, anchoring of piping and backfill.

### Conventional Automatic Sprinkler Systems

In estimating the cost of standard wet or dry-pipe sprinkler systems (as used for fire protection in administrative areas and buildings, inert material operations and storage areas, and building protection in areas where work stations are equipped with individual deluge systems), the cost items to be considered, as applicable, include: water supply line from and connection to the yard distribution or interior fire main, including pipe, fittings, shut-off valves and excavation, anchoring and backfill; alarm valves, flow alarms, dry-pipe or deluge valves; sprinkler heads with branch and main lines in protected area; feed piping from alarm (or dry-pipe or deluge) valve to protected area; enclosure for dry-pipe valve in unheated areas; compressed air supply for dry-pipe systems; local and/or remote alarm and supervisory system; and fire detection system (for pre-action systems).

### Ultra High-Speed Deluge Systems at Work Stations

In estimating costs for this type of system as applied at individual work stations in a munition facility, the cost components to be considered, as applicable, include: the fire detection system, including the ultra-violet flame detectors, control panel, power supply, and wiring; the water delivery system, including a deluge valve, nozzles, shut-off valves, piping from deluge valve to nozzles, and supply piping to the



deluge valve from and connection to the yard distribution or interior fire main including pipe, fittings, shut-off valves and excavation, anchoring and backfill; local and remote alarms and supervisory monitoring systems. Note that one properly selected control panel may be used for several systems depending upon proximity.

#### Hardened Water Curtains in Ramps

In estimating costs for hardened water curtains to be installed at ends of connecting ramps between buildings, the cost components to be considered, as applicable, include: the fire detection system including the ultra-violet flame detectors, control panel, power supply and wiring; the water delivery system, including a deluge valve, hardened nozzles, shut-off valves, piping from deluge valve to nozzles, any required shielding for nozzles and piping, pit for deluge valve (if installed on underground pipeline) and supply piping to the deluge valve from connection to the yard distribution on interior fire main including pipe, fittings, shut-off valves and excavation, anchoring and backfill; local and remote alarms and supervisory monitoring systems. Note that one properly selected control panel may be used for several systems depending upon proximity; it may also be desirable to interconnect the detection system for more than one water curtain so that a fire detected in one ramp will actuate the water curtain in other ramps.

#### Rate-of-Flow Devices for Pressure Loss Protection

In estimating costs for any of the systems discussed in this section where the likelihood exists of severe damage to such system, the cost of providing a rate-of-flow device on the main supply to that system should be added to the estimate. This cost would include the device itself, necessary piping and valves to permit maintenance and testing of the device, and a concrete pit (frostproofed if required) where the rate-of-flow device is installed on an underground line.

#### Halon and Carbon Dioxide Systems for Computer and Motor Control Rooms

In estimating costs for these systems, the cost components to be considered, as applicable, include: the detection system, including smoke detectors, control panel, power supply, alarm system and wiring; the storage containers and manifolding necessary for the Halon or carbon dioxide required to achieve the required concentration in the protected room(s); the nozzles and piping to deliver the extinguishing agent from the storage units



to the protected room. See Section titled "Extinguishing Systems" (Halon Systems) for comment on recharging costs.

#### Demolition

In applications where fire protection systems are to be installed in existing facilities, the cost of removal of, or changes to, the existing systems or structures must be included in the overall estimate.

#### Engineering

After arriving at total cost of materials, equipment, labor, contractor's contingencies, overhead and profit, a percentage should be added to cover the engineering required for the systems involved.

#### Tabulation

Table 2 summarizes applications for the various types of fire protection systems, and the major components to be considered in arriving at a cost estimate for a particular system type.



## REFERENCES

1. "National Fire Codes", published annually by the National Fire Protection Association, Boston, Mass.
2. "Fire Prevention Manual", Department of the Army Technical Manual TM 5-812-1.
3. "Water Supply, General Considerations". Department of the Army Technical Manual TM 5-813-1.
4. "Water Supply, Water Sources", Department of the Army Technical Manual TM 5-813-2.
5. "Water Supply, Water Supply for Fire Protection", Department of the Army Technical Manual TM 5-813-6.
6. "Safety Manual", AMC Regulation 385-100, Headquarters, United States Materiel Command, Washington, D. C. 20315.
7. "Water Supply, Water Storage", Department of the Army Technical Manual TM 5-813-4.
8. "Water Supply, Water Distribution", Department of the Army Technical Manual TM 5-813-5.
9. "Fire Protection Equipment List", published annually by Underwriters' Laboratories, Inc. (UL), 207 East Ohio Street, Chicago, Illinois 60611.
10. "Approval Guide", published annually by the Factory Mutual System (FM), 1151 Boston-Providence Turnpike, Norwood, Mass. 02060.
11. BERGMAN, F., FRISENHALER, J., (Southwest Research Institute), and RINDNER, R., SEALS, W. (ARRADCOM), "Design of a Hardened Water Deluge System for Melt/Pour Plants."
12. "System Safety Program for Modernization and Expansion Projects, MPBMA OSM 385-1, 12 May 1980.
13. System Safety Program Requirements, MIL-STD-882A, 28 June 1977.



Table 1

Summary of fire protection level selections for hardened water curtains at LSAAP 105-mm HE M1 Projectile Melt/Pour Facility

<u>Location of water curtain</u>			<u>Probability of damage to water supply to or in adjoining building due to explosion in:</u>		<u>Protection level selected</u>
<u>Ramp</u>	<u>Adjoining building</u>	<u>Appli-cation</u>	<u>Adjoining building</u>	<u>Nearby building</u>	
RE-25	E-161	1	High	High (E-125)	III
RE-25	E-161	2	Low	Low (E-125)	I
RE-25	E-125	1	High	High (E-161)	III
RE-25	E-125	2	Low	Low (E-161)	I
RE-42	E-120	1 or 2	High	Low (E-123,E-125) <sup>a</sup>	II
RE-43	E-123	1 or 2	High	Low (E-120,E-125) <sup>a</sup>	II
RE-31	E-129	1 or 2	Low	High (E-120,E-123) <sup>b</sup>	II <sup>c</sup>
RE-42) RE-43) RE-44)	E-125	1	High	Low (E-120,E-123) <sup>a</sup>	I <sup>d</sup>
RE-42) RE-43) RE-44)	E-125	2	Low	Low (E-120,E-123)	I
RE-3	E-9	1 or 2	Low	Low (E-4)	I

a. Probability of explosion in E-125 Application 1, and E-120 and E-123 is high, but adjoining building in question is structurally hardened to withstand such incidents.

b. Water supply to E-162 is subject to damage. Since E-129 is served by same branch main as E-162, rate-of-flow device should be placed in sub-branch to E-162.

c. See text, page 36, last two sentences.

d. Rate-of-flow device in E-125 supply provided for with RE-25 curtain.



Table 2

## Summary of application and cost components of fire protection system

Type of system	Ultra high-speed deluge systems		Conventional Sprinkler systems (including wet, dry and pre-action)	Total flooding Systems - Halon or carbon dioxide
	Local application systems	Hardened water curtains		
Typical applications in munition plants	At work stations involving hazardous operations and materials.	At end of ramps conveying hazardous materials.	1) General building protection in hazardous areas. 2) Administrative areas. 3) Inert materials storage and operation areas. 4) Packout areas.	1) Computer rooms 2) Motor control rooms 3) Electrical equipment rooms
Cost components				
A. Fire detection systems <sup>a</sup>				
1. Flame detectors	Ultra-violet type	Ultra-violet type	None	None
2. Smoke or heat detectors	None	None	For pre-action systems and alarms.	Required
3. Control panel <sup>b</sup>	Required	Required	For pre-action systems and alarms.	Required
4. Power supply <sup>c</sup>	Required	Required	For pre-action systems and alarms.	Required
5. Wiring	Required	Required	For pre-action systems and	Required
B. Water (or agent) delivery system				
1. Nozzles	Spray nozzles	Hardened spray nozzles <sup>e</sup>	Ordinary sprinklers	Special nozzles <sup>f</sup>
2. Control valve	Deluge valve	Deluge valve	Alarm check or dry pipe valve	Special release valve <sup>f</sup>
3. Shut-off valves	Required	Required	Required	Required <sup>f</sup>
4. Piping from control valve to nozzles	Required	Required <sup>e</sup>	Required	Required <sup>f</sup>
5. Piping from supply main to control valve <sup>d</sup>	Required	Required	Required	Not applicable
6. Excavation, back-fill and anchoring for underground lines	As required	As required	As required	Not applicable
7. Rate-of-flow devices and associated valves	As required	As required	As required	Not applicable
8. Pits for rate-of-flow devices	As required	As required	As required	Not applicable
9. Interior enclosures	None	None	For dry-pipe valve	As required for cylinders.
10. Compressed air	Not applicable	Not applicable	For dry-pipe and pre-action systems.	Not applicable

a. Include supervisory alarms.

b. One control panel may serve several systems.

c. Power supply may serve several systems.

d. Include inter-connecting wiring for curtains at both ends of each ramp.

e. Include shielding against fragments, if required.

f. Modular Halon systems may not require separate nozzles, release valve, shut-off valve or piping.

g. Include connection(s) to existing supply main(s).



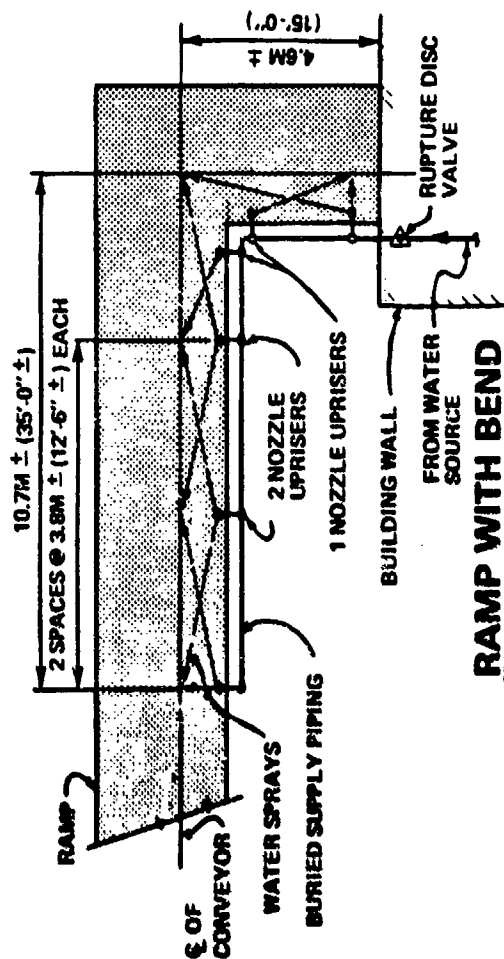
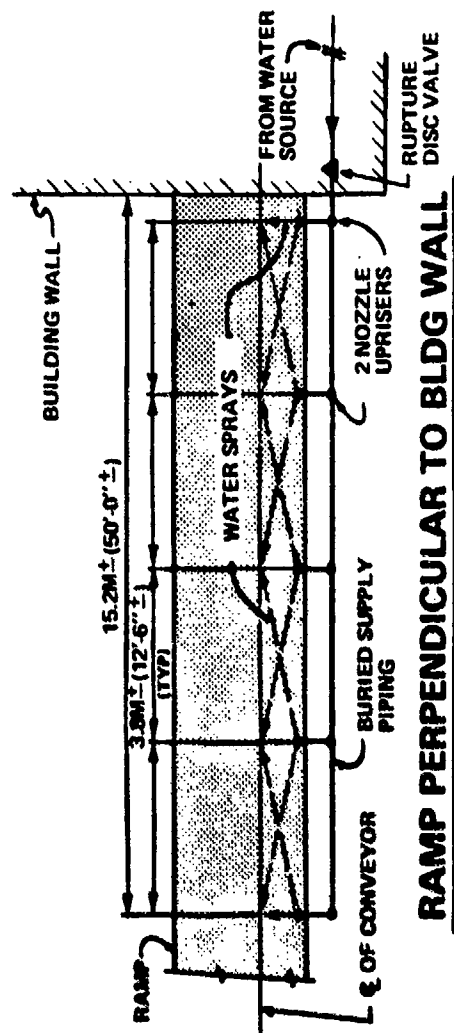
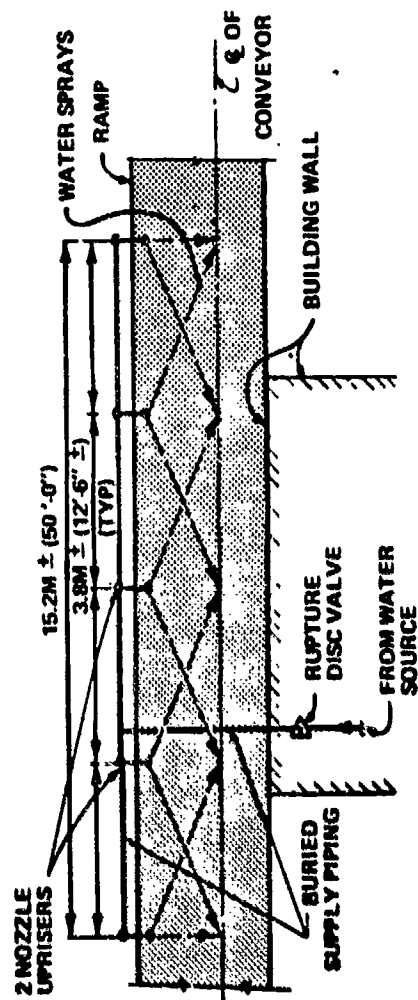


Fig 1 Typical hardened water curtain modules



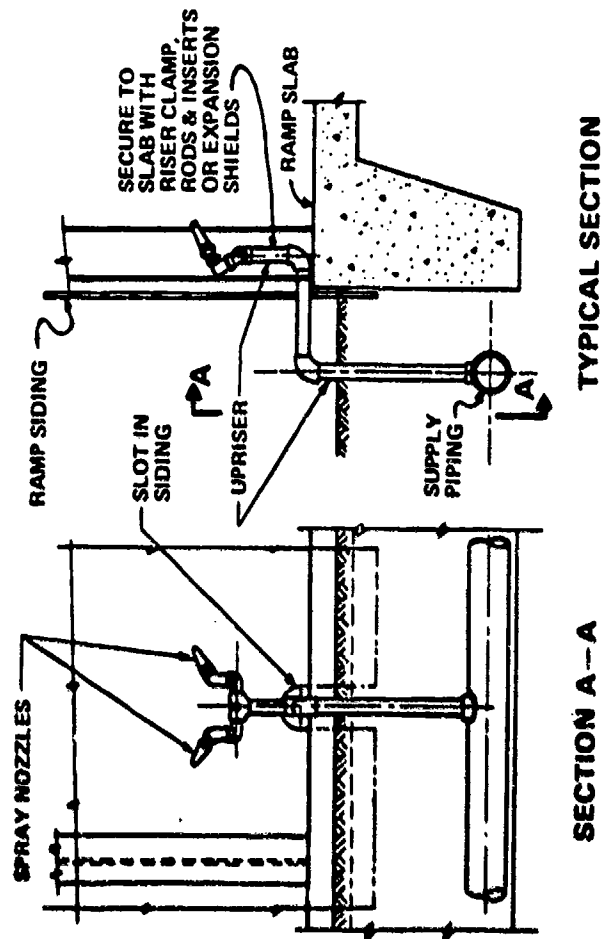
# **RAMP PARALLEL TO BUILDING WALL**



**Fig 2 Typical hardened water curtain module**



# **TYPICAL ARRANGEMENT OF UPRISER AND NOZZLES UNSHIELDED**



**Fig 3 Typical arrangement of upriser and nozzles-unshielded**

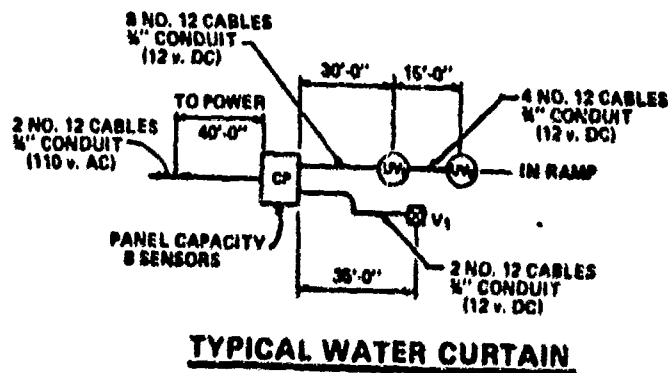
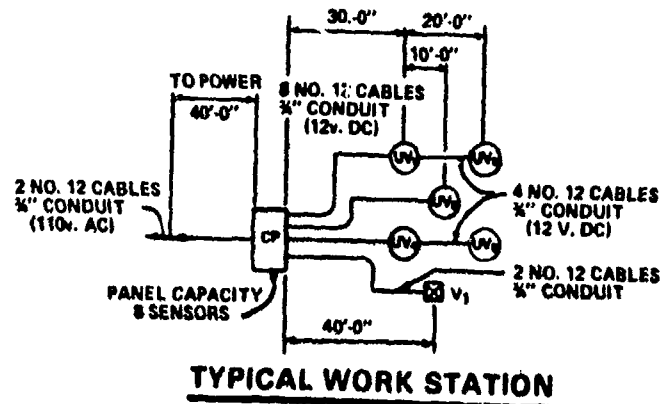


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**Fig 4 Typical arrangement of upriser and nozzles-shielded**



## FIRE DETECTION SYSTEM CIRCUITRY



**LEGEND:**

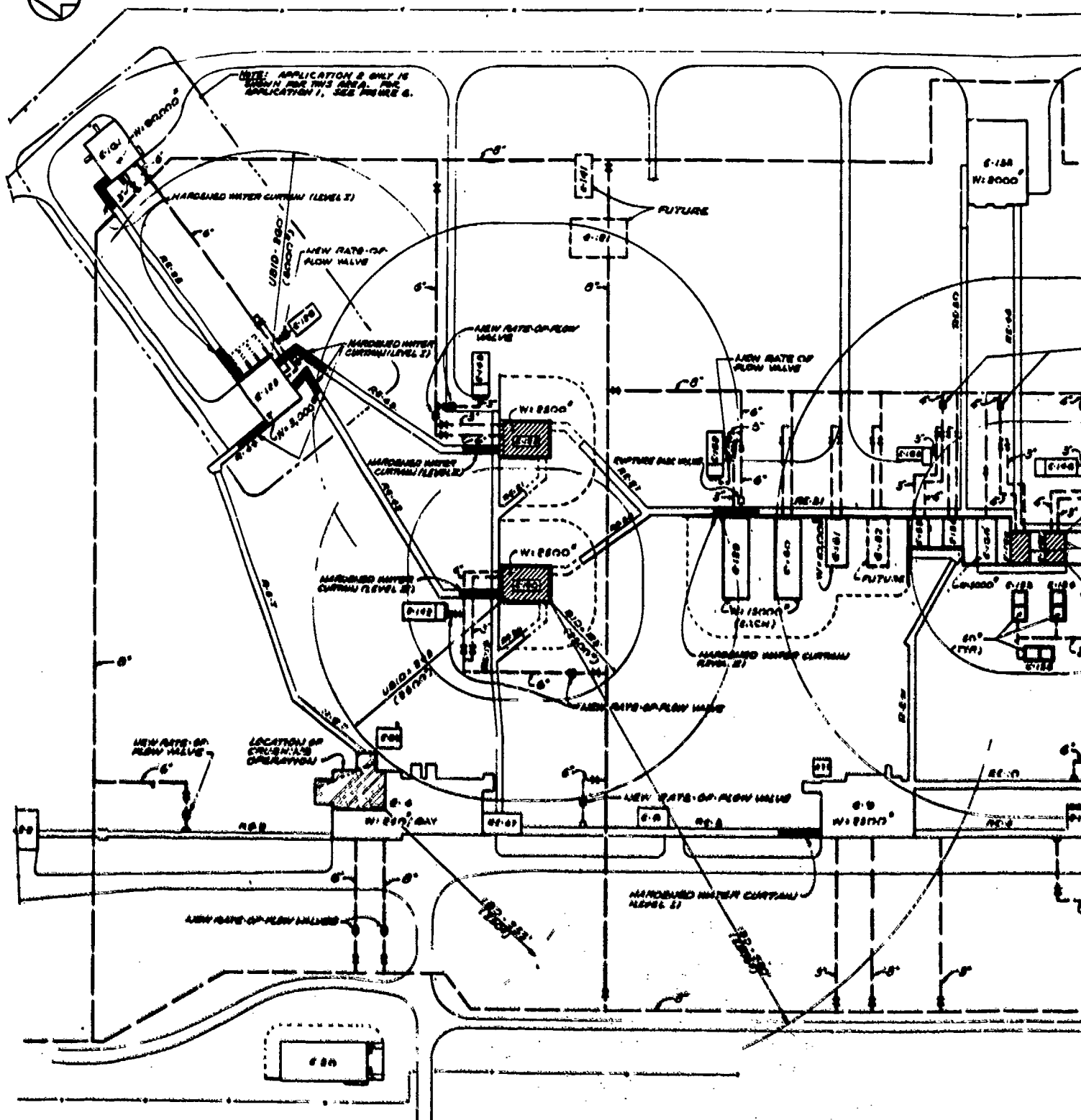
C.P. - CONTROL PANEL  
 U.V. - SENSOR  
 V. - VALVE

**Fig 5 Fire detection systems circuitry**



**Fig 6 Lone Star 105-mm HE M1 LAP Facility**











FOR NOTES AND LEGEND  
SEE FIGURE 7.

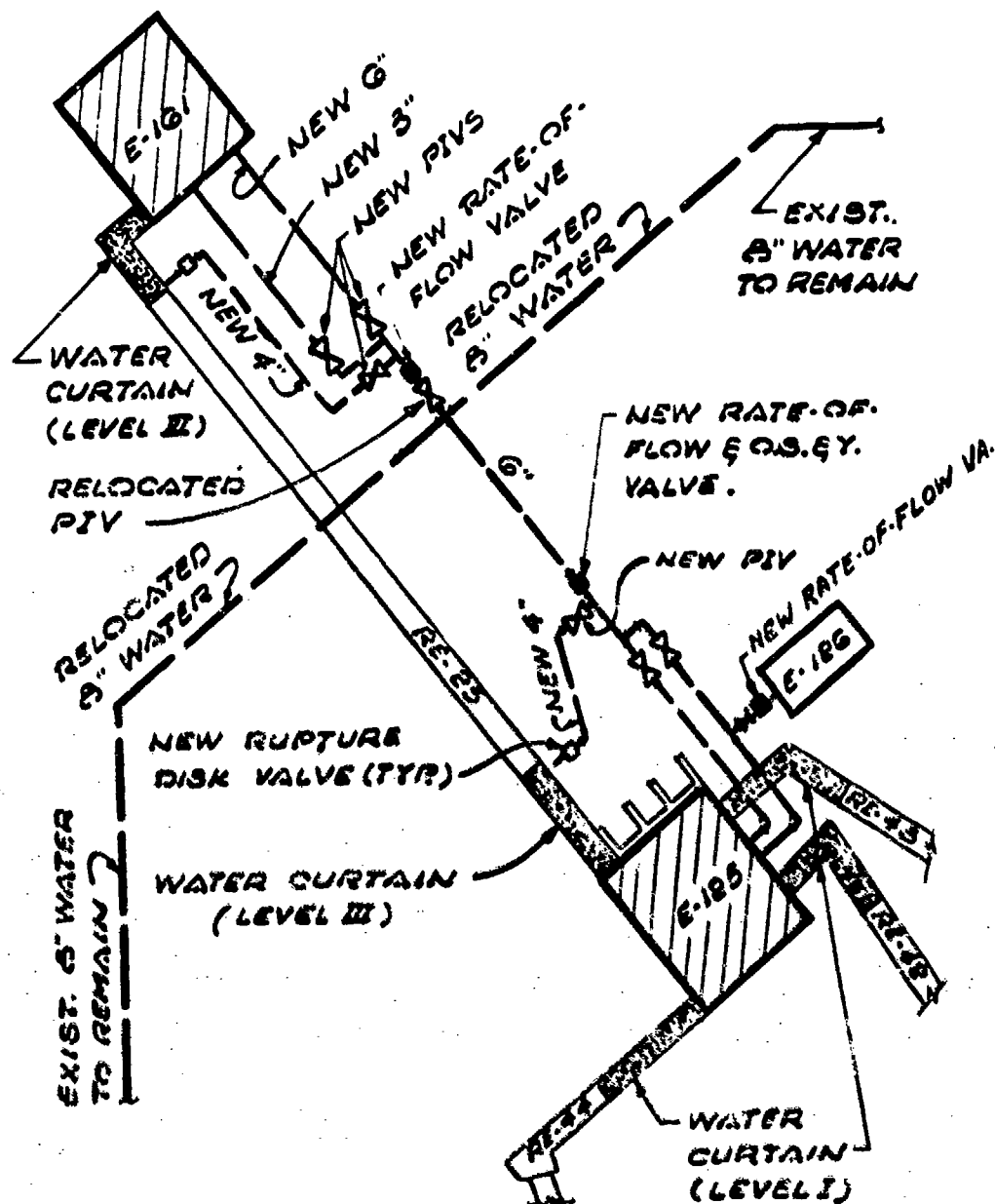


Fig 8 Enlarged detail (Application 1) - See Figure 7



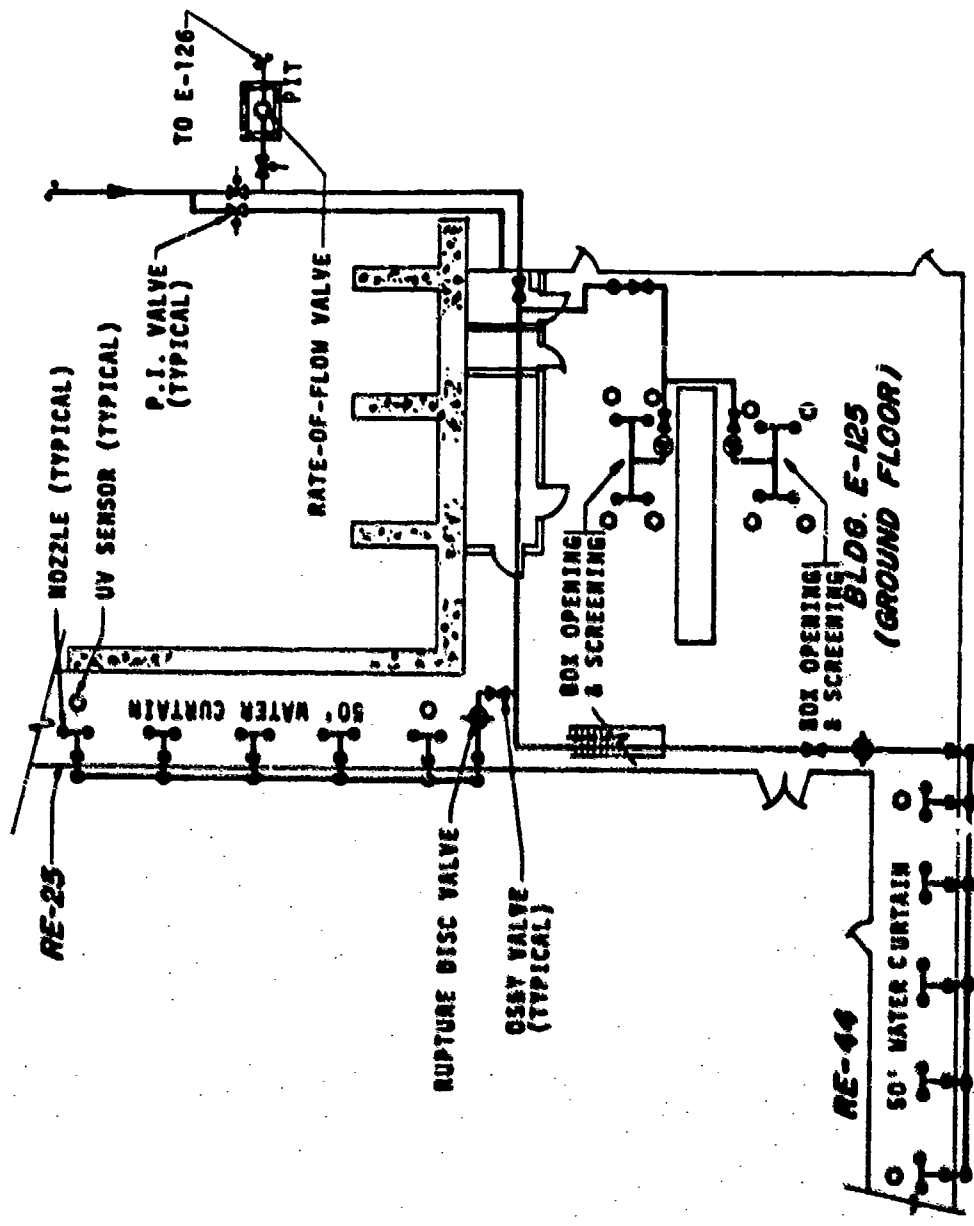


Fig 9 Schematic - building E-125 (ground floor) and ramps RE-25 and RE-44



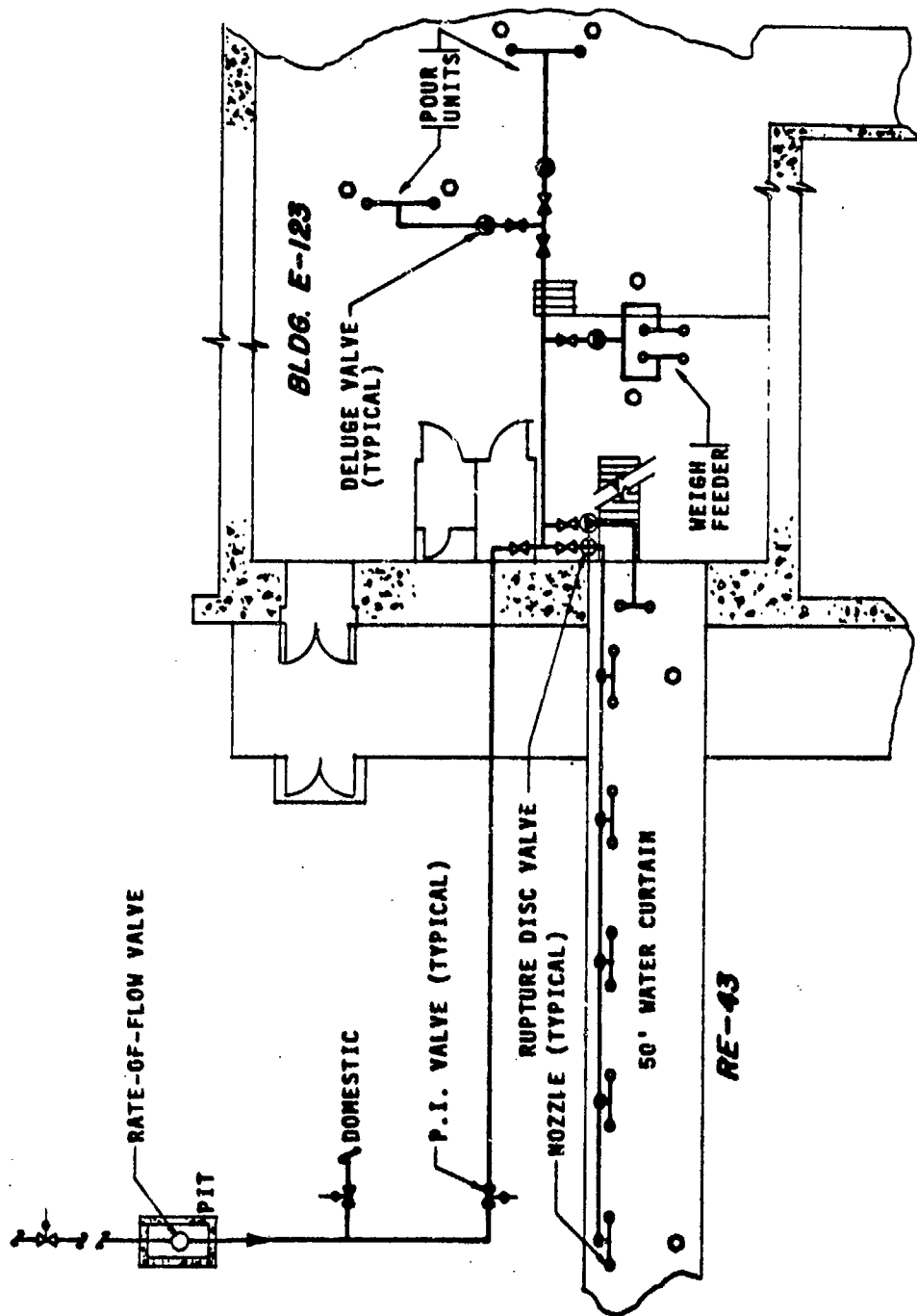


Fig 10 Schematic - building E-123 and ramp RE-43



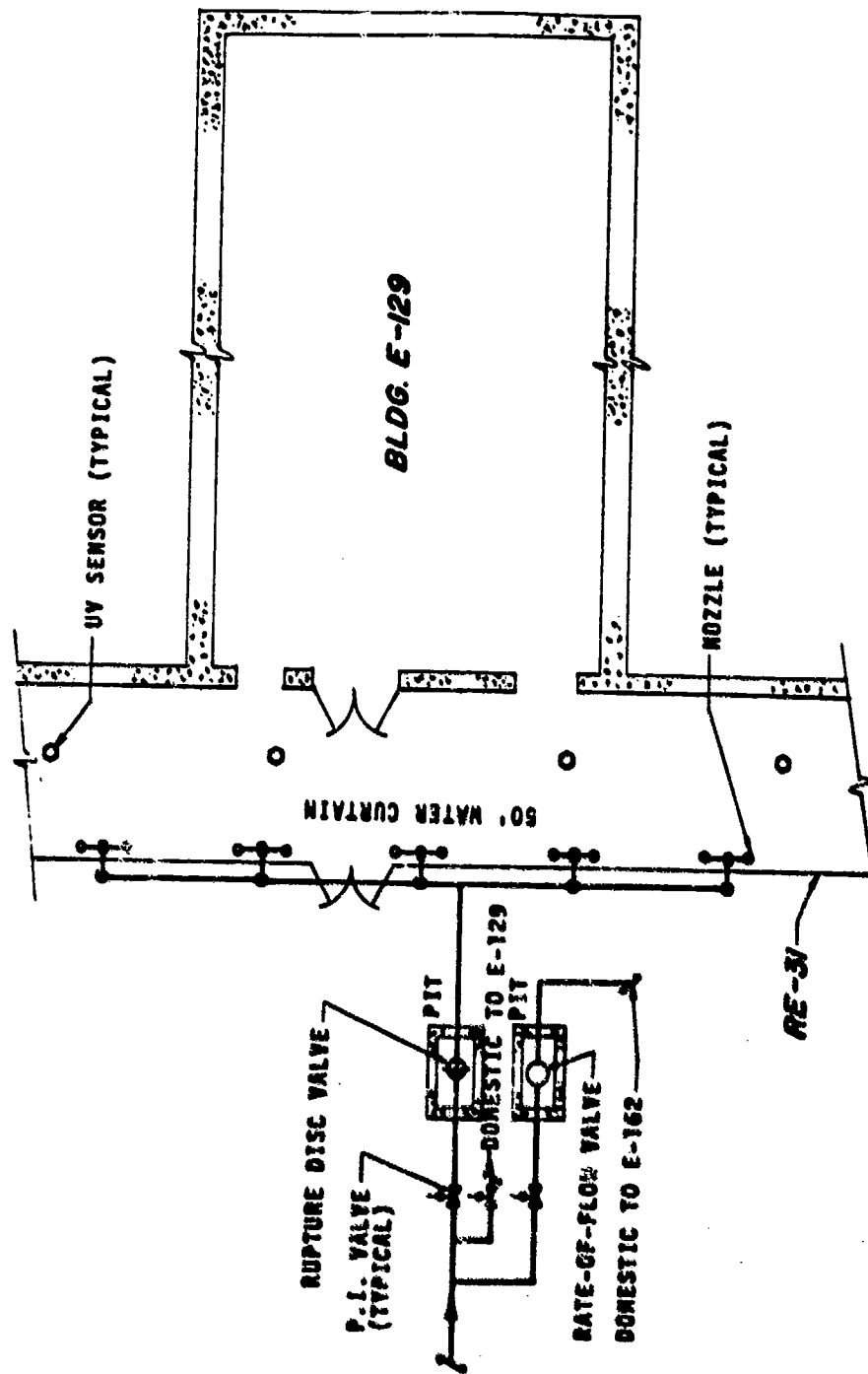


Fig 11 Schematic - building E-129 and ramp RE-31



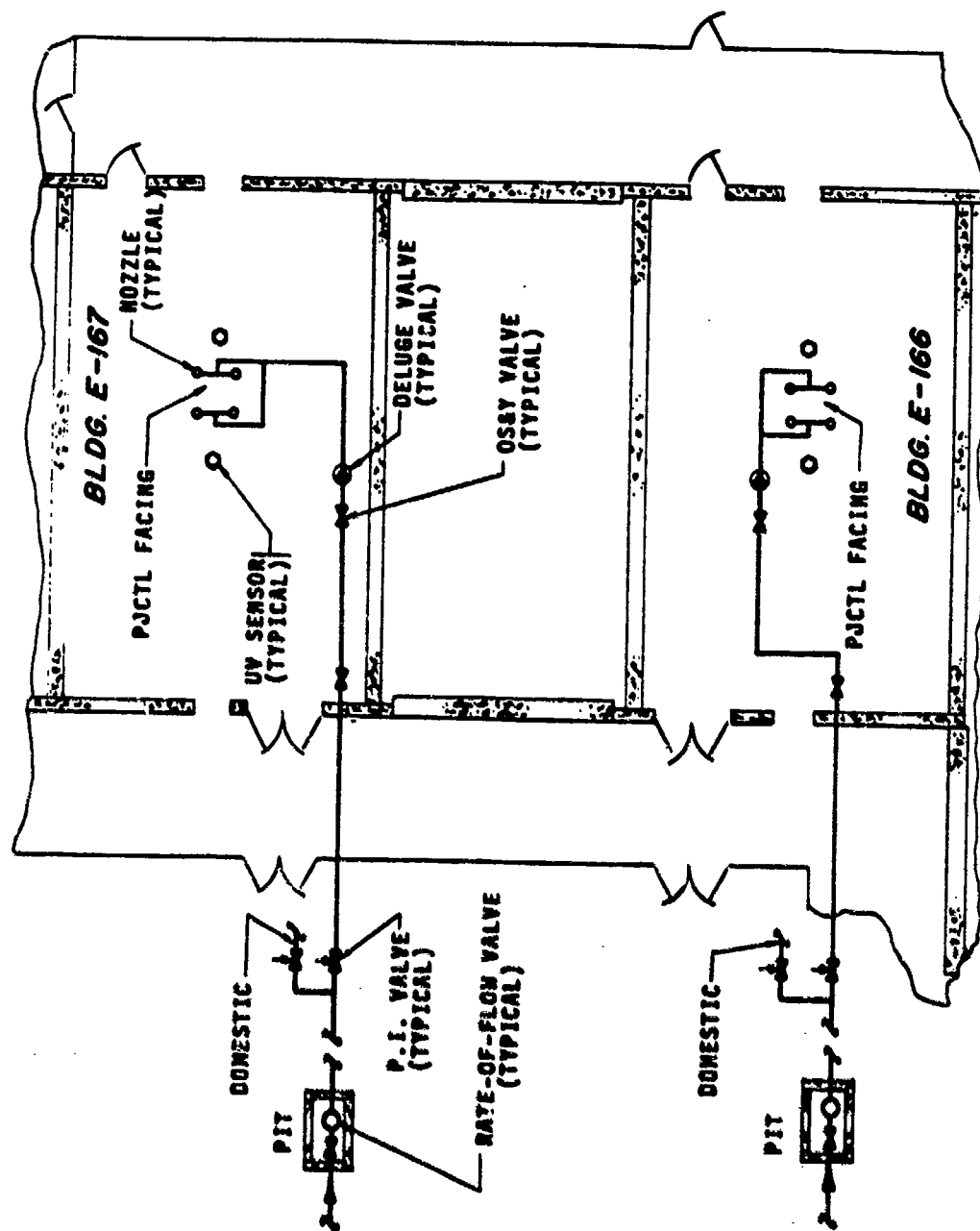


Fig 12 Schematic - buildings E-166 and E-167



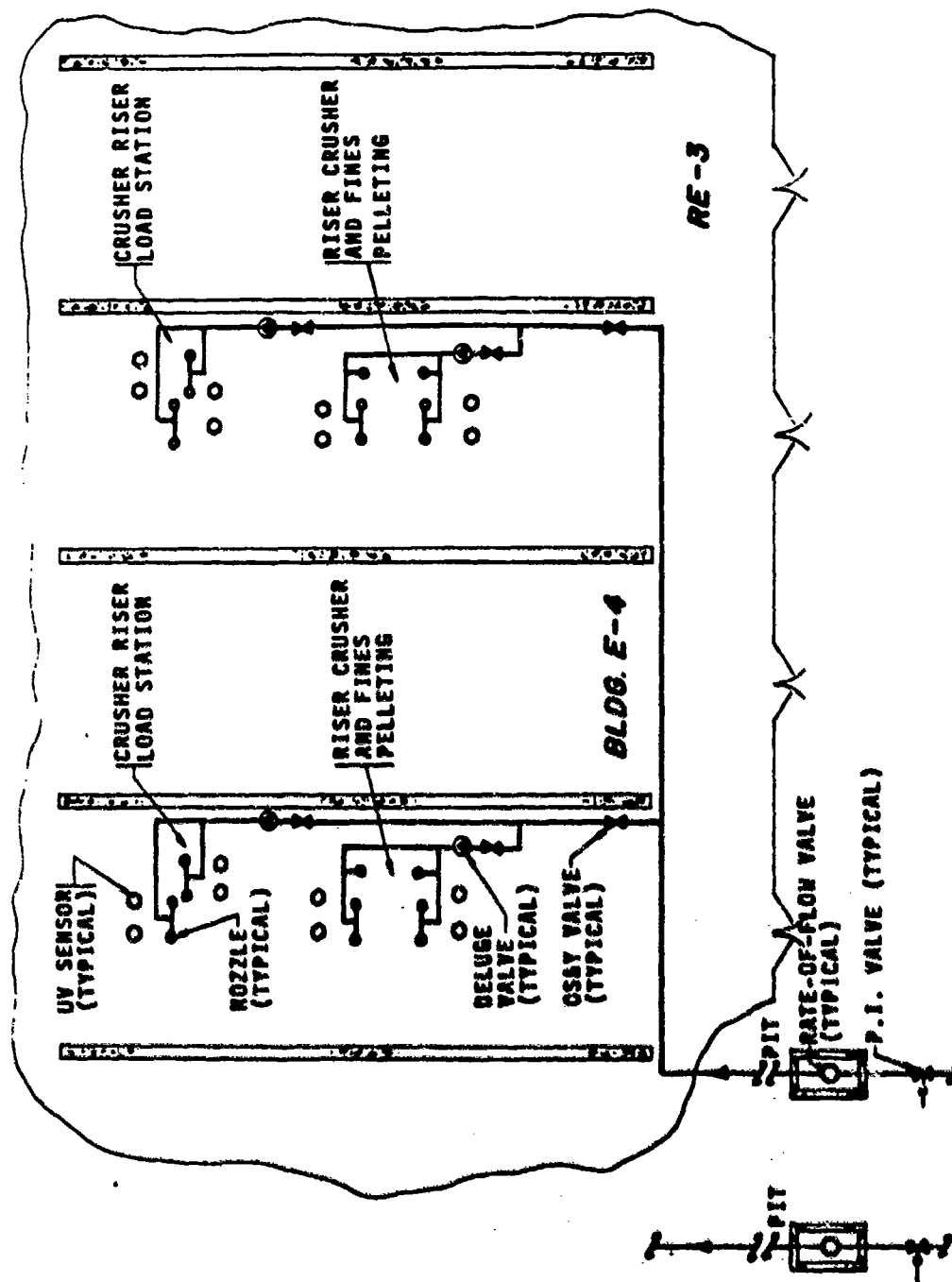


Fig 13 Schematic - building E-4 (partial)



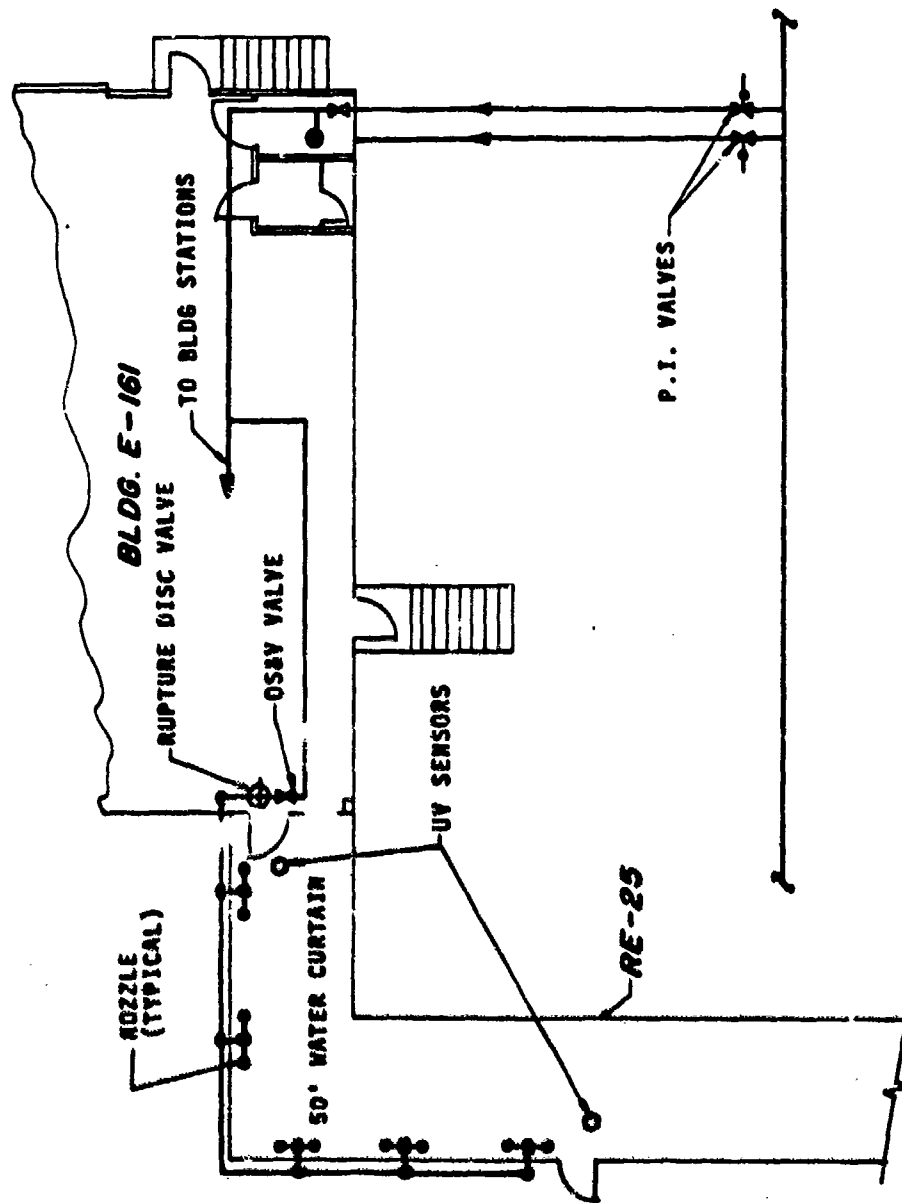


Fig 14 Schematic - building E-161 (partial) and ramp RE-25



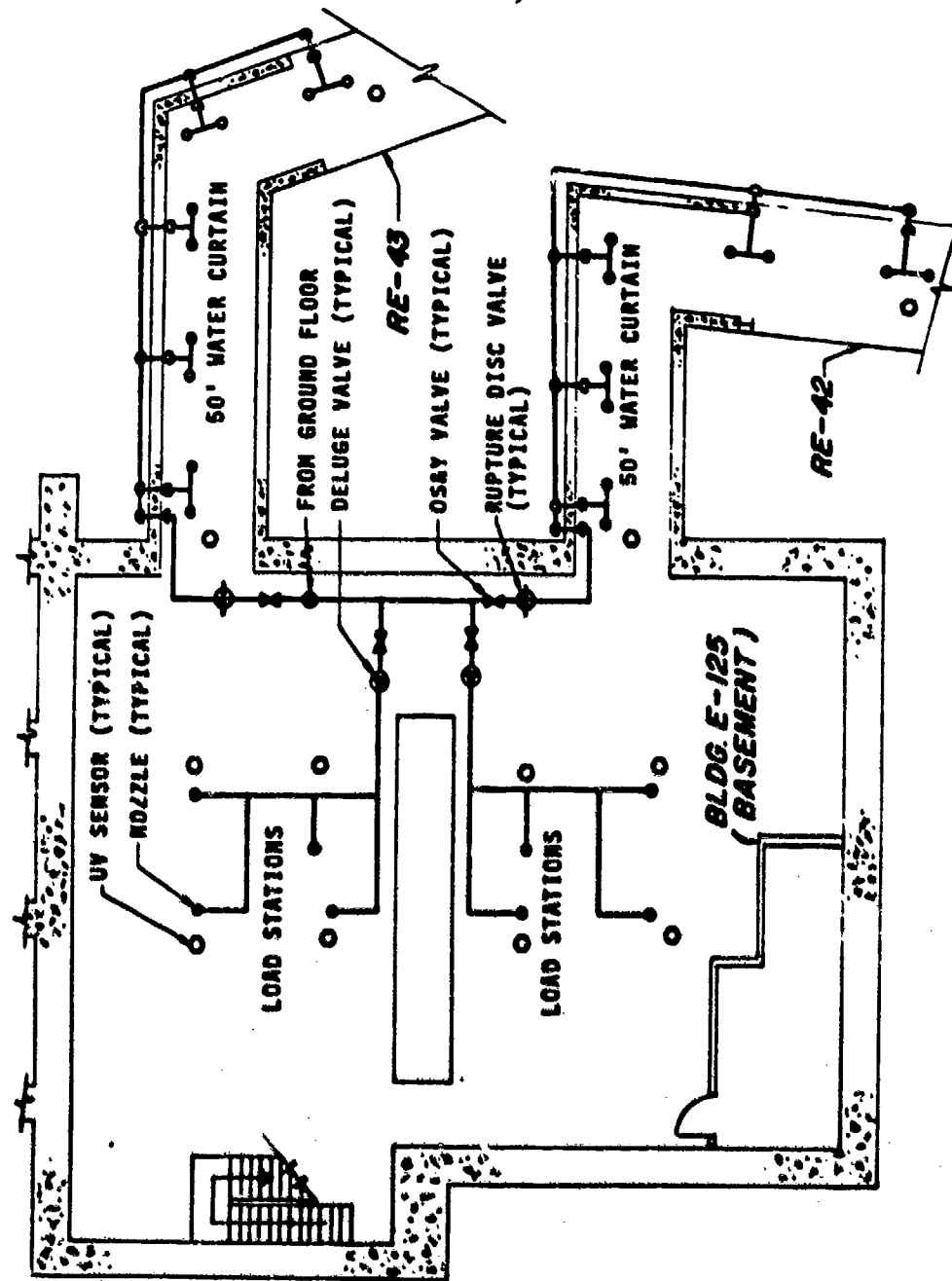


Fig 15 Schematic - Building E-125 (basement) and Ramps RE-42 and RE-43



DONOR		ACCEPTOR	
STRUCTURE	PROCESS & EXPL QTY (LBS)	STRUCTURE (LBS)	PERSONNEL
BLDGS: E4  E120 OR E123	RISER SCRAP HANDLING 300 MELT/POUR 2500 EACH	BLDGS: E125 6000 E161 90,000	YES  YES
BLDGS: E166 OR E167	THREAD CLEANING 500 EACH	BLDGS: E138 2000	YES
BLDGS: E120 OR E123	MELT/POUR 2500 EACH	BLDGS: E120 OR E123	NO

Fig 16 Safety design criteria - Lone Star AAP 105-mm HE M1 LAP Facility



- BLDG E125 AND E161 STRUCTURALLY HARDENED TO RESIST EXPLOSION IN E4, E120 OR E123
- BLDG E138 STRUCTURALLY HARDENED TO RESIST EXPLOSION IN E166 OR E167
- BLDG E120 STRUCTURALLY HARDENED TO RESIST EXPLOSION IN E123; VICE VERSA
- HIGH PROTECTION CRITERIA - APPLICATION 1
  - HIGH POTENTIAL FOR EXPLOSION: E4, (E120, E123), E125, E161, (E166, E167)
  - HIGH POTENTIAL FOR EXPLOSION IN E161 FOR MASSIVE DAMAGE THROUGHOUT FACILITY
- LOWER PROTECTION CRITERIA - APPLICATION 2
  - HIGH POTENTIAL FOR EXPLOSION: E4, (E120, E123), (E166, E167)
  - LOW POTENTIAL FOR EXPLOSION: E125, E161

Fig 17 Fire protection design criteria - Lone Star AAP 105-mm HE M1 LAP Facility



#### **INCIDENT**

- DONOR STRUCTURES E125 OR E161 (ASSUMED)
- ACCEPTOR STRUCTURE DAMAGE IN EITHER BUILDING SEVERE
- ACCEPTOR STRUCTURE DAMAGE IN WATER CURTAINS SEVERE
- DONOR STRUCTURE WATER MAIN BREAKS; NO PRESSURE TO FIGHT FIRES ELSEWHERE

#### **CONCLUSIONS**

- PROTECTION LEVEL III, APPLICATION 1 APPLIES
- MODIFY EXTERIOR DONOR STRUCTURE WATER MAIN TO OPERATE

#### **SYSTEM REQUIREMENTS**

- DIRECT CONNECT WATER MAIN TO CURTAIN
- DIRECT CONNECT WATER MAIN TO BUILDING
- USE RATE-OF-FLOW AND OS&Y VALVES ON EXTERIOR MAIN IN FROST FREE PITS

Fig 18 Application 1, protection level III - Lone Star AAP 105-mm HE M1 LAP Facility



#### INCIDENT

- DONOR STRUCTURES E125, E120 OR E123 (ASSUMED)
- ACCEPTOR STRUCTURE DAMAGE E120, E123 MINIMAL (EARTH MOUNDED STRUCTURES)
- ACCEPTOR STRUCTURE DAMAGE TO WATER CURTAINS SEVERE

#### CONCLUSIONS

- PROTECTION LEVEL II, APPLICATION 1 APPLIES
- MODIFY ACCEPTOR STRUCTURE WATER CURTAIN TO OPERATE (SECOND STORY RAMP)

#### SYSTEM REQUIREMENTS

- DIRECT CONNECT WATER SUPPLY TO BUILDING, THEN TO CURTAIN. RUPTURE DISC VALVE IN BUILDING
- USE RATE-OF-FLOW VALVE TO CONTROL WATER DISCHARGE

Fig 19 Application 1, protection level II - Lone Star AAP 105-mm HE M1 LAP Facility



#### INCIDENT

- DONOR STRUCTURE E4 (ASSUMED)
- ACCEPTOR STRUCTURE DAMAGE E9 MINIMAL
- DONOR STRUCTURE DAMAGE TO RAMP RE-3 SEVERE (WOOD WITH UNHARDENED SPRINKLERS)
- FIRE SPREADS FROM E4 TO E9 ALONG RAMP

#### CONCLUSIONS

- PROTECTION LEVEL 1, APPLICATION 1 APPLIES
- MODIFY ACCEPTOR STRUCTURE WATER SUPPLY

#### SYSTEM REQUIREMENTS

- DIRECT CONNECT WATER SUPPLY TO BUILDING, THEN TO CURTAIN. RUPTURE DISC VALVE IN BUILDING
- WATER MAIN WITH RATE-OF-FLOW VALVE FOR SPRINKLER IN WOOD RAMP

Fig 20 Application 1, protection level 1 - Lone Star AAP 105-mm HE M1 LAP Facility



**INCIDENT**

- DONOR STRUCTURE E166 OR E167 (ASSUMED)
- ACCEPTOR STRUCTURE DAMAGE E138 MINIMAL (HARDENED STRUCTURE)
- ACCEPTOR STRUCTURE DAMAGE E146, E150, E153, E154, E155, E165 SEVERE

**CONCLUSIONS**

- APPLICATION 1 APPLIES - NO CURTAINS
- ACCEPTOR STRUCTURE E138 REQUIRES NO CURTAINS; NON-PROPAGATION SITUATION IN RAMP
- ACCEPTOR STRUCTURE FOR REMAINDER DO NOT HAVE RAMPS OR CURTAINS
- MODIFY DONOR WATER MAIN

**SYSTEM REQUIREMENTS**

- USE RATE-OF-FLOW VALVE IN WATER SUPPLY TO DONOR & ACCEPTOR STRUCTURES

Fig 21 Application 1, Balance of Facility - Lone Star AAP 105-mm HE M1 LAP Facility



## APPENDICES

### REPRESENTATIVE SYSTEMS AND EQUIPMENT

The appendices contain reduced-size copies of manufacturers' literature showing representative examples of available fire detection and extinguishing systems and equipment.

Appendix A - Heat, smoke and flame detectors

Appendix B - Detection system panels and power supply units

Appendix C - Fire extinguishing systems and equipment



APPENDIX A

HEAT, SMOKE AND FLAME DETECTORS

REPRESENTATIVE SYSTEMS AND EQUIPMENT



## General

The ceiling mounted sensors are designed for use with Fire Detection and Alarm Control Panels, and contain terminals, terminal block, fusible element, and switch contact. They are listed by Underwriters' Laboratories, Inc. and approved by Factory Mutual System.

## Features

- Easily replaceable fusible element.
- A standard 3-1/4 or 4 in. (83 or 102mm) octagonal outlet box with accessory mounting plate may be used. Knockouts are provided in plastic base for use with exposed wiring (A model only).

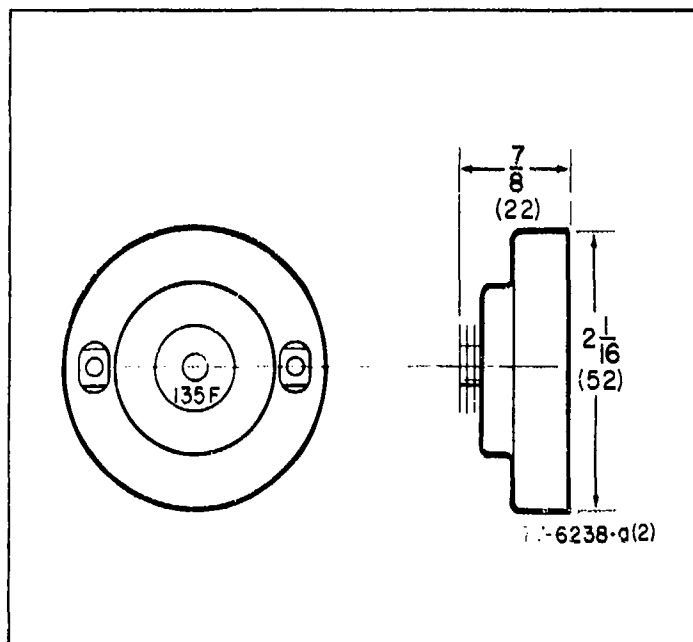
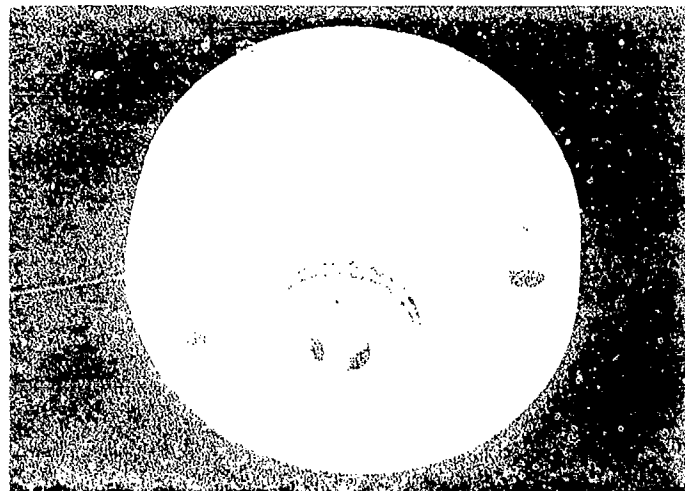
## Specifications

### MODELS

T4010A Fire Sensor with spst switching.  
T4010C Fire Sensor with dpst switching with No. 803257 mounting plate.

### RATING IN AMPERES

6 to 125 volts ac .....	6.0
6 to 28 volts dc .....	3.0
125 volts dc .....	1.0
250 volts dc .....	0.3



T4010 APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)

Fig 1 Heat detectors -fixed temperature



### General

These Fire Detectors are used with Fire Detection and Alarm System Panels to provide positive, rapid fire detection. They are ceiling mounted, and serve as a temperature actuated switch to initiate an audible alarm signal or other alarm output. They are listed by Underwriters' Laboratories, Inc.

### Features

- Low profile device that utilizes a reversible mounting plate, shipped with each detector, and adaptable for either junction box or surface mounting. All mounting screws are concealed.
- Fixed-temperature operation is easily identified by the fact that the heat-collector disc drops away from the detector.

### Specifications

#### MODELS

**T4057A Automatic Fire Detector-Combination rate-of-rise and fixed temperature.**

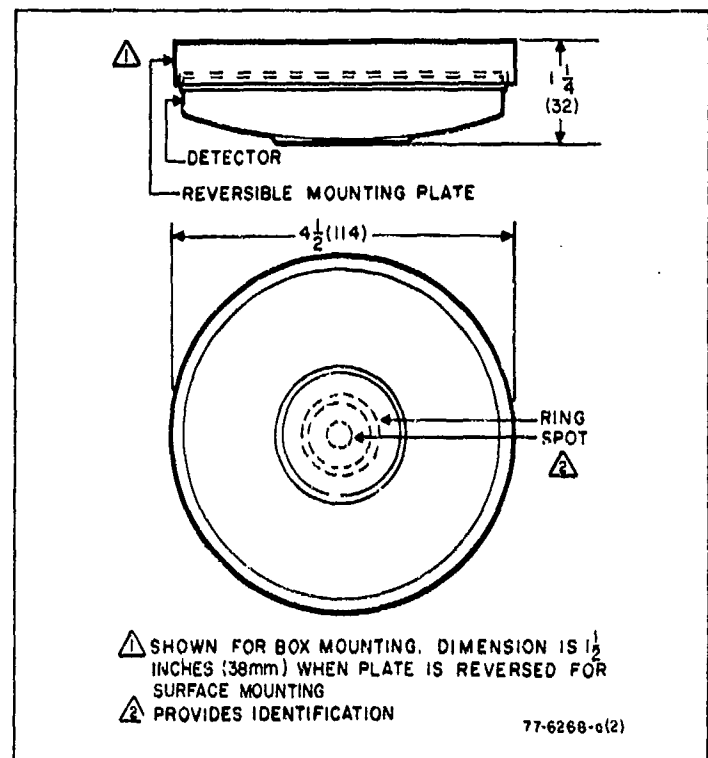
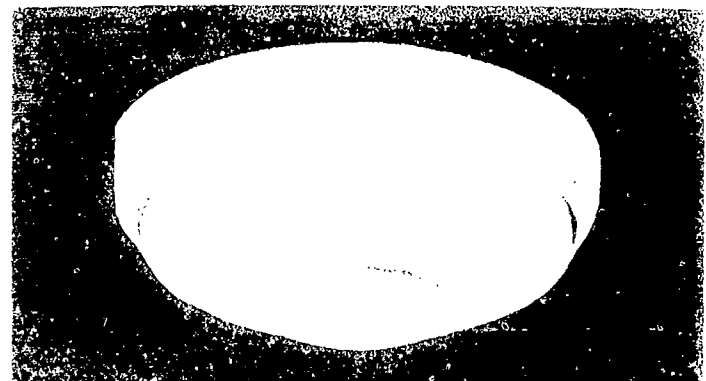
**T4057B Automatic Fire Detector-Fixed temperature only.**

#### RATING IN AMPERES

8 to 125 volts, ac .....	3.0
6 to 28 volts, dc .....	1.0
125 volts dc .....	0.3
250 volts dc .....	0.1

#### SWITCHING

Available with either one or two sets of normally open (N.O.) contacts. Contacts close on temperature increase.



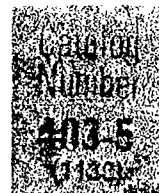
**T4057 APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)**

**Fig 2 Heat detectors - fixed temperature and combination rate-of-rise and fixed temperature**



# Thermal Plug-In Fire Detectors

MODELS DTF-136P, DTF-190P,  
DTR-136P, DTR-190P



Pyrotronics 16p PROTECTIVE SYSTEMS

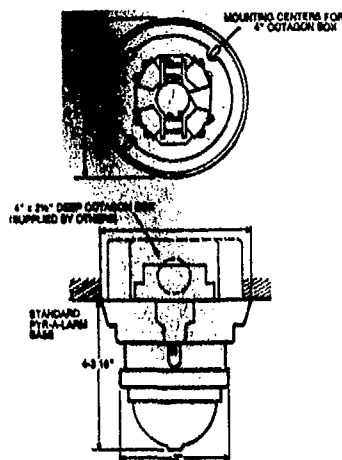


## INTRODUCTION

The Pyr-A-Larm Plug-In Thermal Fire detectors are of the fixed temperature or combination fixed temperature/rate-of-rise type. The combination detectors consist of two independently operated thermal elements. The rate-of-rise element is self-restoring. The fixed temperature element is of the non-restoring type. The plug-in thermal detectors are designed for use with the standard Pyr-A-Larm Detector base. Located on the base is a lamp which visually indicates the initiation of an alarm.

Underwriters' Laboratories, Inc., recommends the combination type thermal detector be used to protect a maximum of 2,500 square feet, and the fixed temperature type be used to protect a maximum of 225 square feet. Job conditions and engineering judgment, however, often dictate closer spacing to provide faster detection.

## MOUNTING DATA



## RATE-OF-RISE PRINCIPLE OF OPERATION

Basically, the rate-of-rise element consists of an air chamber, a flexible diaphragm, and a carefully calibrated vent.

It is well known that air expands as it is heated, and contracts as it is cooled. For normal daily fluctuations of temperature, the natural expansion and contractions of the air in the chamber is automatically compensated by the "breathing" action of the vent. However, when a fire occurs, air temperatures rise very rapidly and the air in the chamber expands faster than it can be vented. This creates a pressure which distends the diaphragm and closes electrical contacts.

The rate-of-rise action is not related to any fixed temperature level, but responds promptly when the rate exceeds 15° per minute. When the heat is removed, the air within the chamber contracts, relieving the pressure and restoring the electrical contacts to a normally open circuit position.

## FIXED TEMPERATURE OF OPERATION

The fixed temperature element is entirely independent of the rate-of-rise element and is the non-restorable type. In a slow developing fire, the temperature may not increase rapidly enough to operate the rate-of-rise element. However, when the fixed temperature element is heated to its rated temperature, its operation is as follows:

A fusible alloy, melted by the heat, releases a spring to close the electrical contacts. A "tell-tale" hole appears in the detector shell and indicates the fired detector. The detector cannot be reset after operation and must be replaced.

These thermal detectors respond only to heat, so they are suitable for use in areas where normal conditions would prohibit the use of Pyr-A-Larm ionization detectors.

When connected to Pyr-A-Larm control equipment, the detectors are fully compatible with Pyr-A-Larm ionization detectors, flame detectors, and manual stations. Electrically, any number of thermal detectors can be used in a circuit. The limit is only subject to the practical considerations of job conditions and engineering judgement.



**Pyrotronics**

A Division of Baker Industries, Inc.  
8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

June, 1973

Supersedes Sheet dated 5/72

Fig 3 Heat detectors - fixed temperature and  
combination rate-of-rise and fixed temperature

Pyrotronics 16p PROTECTIVE SYSTEMS





Engineer and Architect Specifications

# Thermal Plug - In Fire Detectors

MODELS DTC-135P, DTC-200P

Pyrotechnics 16p PROTECTIVE SYSTEMS

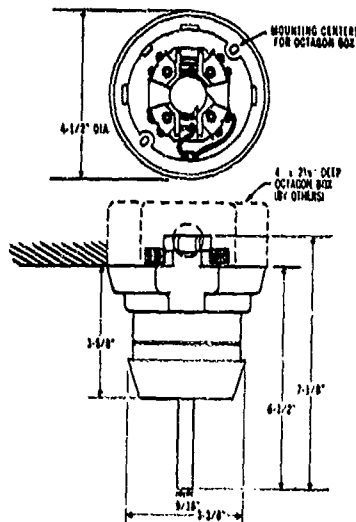


## INTRODUCTION

The Pyr-A-Larm Plug-In Thermal Fire Detectors are of the rate compensation/fixed temperature type and are designed for use with the standard Pyr-A-Larm Detector base. Though the detector element is self-restoring, the detector locks in upon alarm, therefore it must be reset at the control panel. The detector is supplied in ratings of 135° F and 200° F. A lamp is located on the base to visually indicate the initiation of an alarm.

Underwriters' Laboratories, Inc., recommends the Thermal Detector be used to protect a maximum of 2,500 square feet. Job conditions and engineering judgment, however, often dictate closer spacing to provide faster detection. The Models DTC-135P and DTC-200P are Underwriters' Laboratories, Inc., listed.

## MOUNTING DATA



DETECTOR REMOVED FROM BASE

## PRINCIPLE OF OPERATION

Basically the detector consists of an aluminum tubular shell containing two curved expansion struts under compression fitted with a pair of normally open, opposed contact points which are in-



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

August, 1974

NEW ISSUE

Fig 4 Heat detectors - rate compensation

Pyrotechnics 16p PROTECTIVE SYSTEMS



# **PYR-A-LARM®** Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

## **Thermal Fire Detectors**

Catalog  
Number  
**6131**

MODELS DT-135CL, DT-200CL, DT-135C,  
DT-200C, DT-135CS, DT-200CS

Pyrotronics 16p PROTECTIVE SYSTEMS

### INTRODUCTION

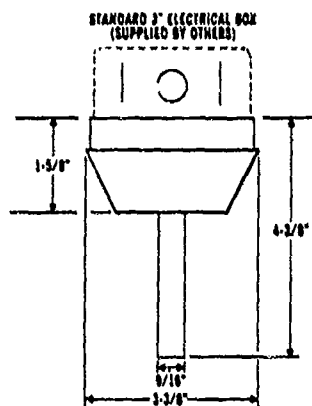
The Pyr-A-Larm Thermal Fire Detectors are of the rate compensation/fix temperature type and are designed for use with either standard Pyr-A-Larm systems or other commercially available fire alarm systems. In all models the detector element is self-restoring after operation and are supplied in ratings of 135°F and 200°F.

Underwriters' Laboratories, Inc. recommends the Thermal Detector be used to protect a maximum of 2,500 square feet. Job conditions and engineering judgment, however, often dictate closer spacing to provide faster detection.

The Models DT-135CL and DT-200CL are used with Pyr-A-Larm low voltage systems where it is desirable to provide visual identification of an operated detector by means of an internally mounted incandescent lamp. These models lock in upon alarm, therefore they must be reset at the control panel.

The Models DT-135C and DT-200C are also used with Pyr-A-Larm low voltage systems but are not fitted with an indicator lamp and do not lock in upon alarm.

### MOUNTING DATA



NOTE - ADAPTER RING REQUIRED FOR 4\" BOX

The Models DT-135CS and DT200CS can be used with any fire alarm circuit of any manufacture using open circuit direct shorting type units. These units do not contain a series-connected resistor or an indicator lamp and do not lock in upon alarm. Contact ratings are 6-125 Vac, 5 amps; 6-25 Vdc, 1 amp; 125 Vdc, 0.5 amps.

The Models DT-135CL, DT-200CL, DT-135C, DT-200C, DT-135CS and DT-200CS are Underwriters' Laboratories, Inc. listed.

Note: Explosion proof versions of these models are also available; contact Pyrotronics' System Application Department for information.

### PRINCIPLE OF OPERATION

Basically the detector consists of an aluminum tubular shell containing two curved expansion struts under compression fitted with a pair of normally open, opposed contact points which are insulated from the shell. The tubular shell and the struts have a different coefficient of expansion. When subjected to a rapid heat rise the tubular shell expands and lengthens slightly. At the same time the interior struts lengthen but at a slower rate than the shell. The rapid lengthening of the shell allows the struts to come together, thereby closing the contact points and initiating the alarm.

When subjected to a very slow heat rise the tubular shell and the interior struts lengthen at approximately the same rate. At the detectors' set temperature point 135°F or 200°F, the interior struts are fully extended, thereby closing the contact points and initiating the alarm.

These thermal detectors, which are shock and corrosion resistant, respond only to heat, so they are suitable for use in areas where normal conditions would prohibit the use of other Pyr-A-Larm detectors.

When connected to Pyr-A-Larm control equipment the Models DT-135CL, DT-200CL, DT-135C and DT-200C detectors are fully compatible with Pyr-A-Larm ionization detectors, flame detectors, and manual stations. Electrically, any number of thermal detectors can be used in a circuit. The limit is only subject to the practical considerations of job conditions and engineering judgment.

In addition to operating their own internal alarm indicating lamps, the Models DT-135CL and DT-200CL can also operate one remote indicating lamp when desired.

Pyrotronics 16p PROTECTIVE SYSTEMS



**Pyrotronics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

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NEW ISSUE

Fig 5 Heat detectors - rate compensation



**PYR-A-LARM®**  
EARLY WARNING FIRE DETECTION AND ALARM SYSTEMS

# Thermal Plug-In Fire Detectors

Catalog  
Number  
**6132**

Engineer and Architect Specifications

MODELS DT-135CPS, DT-200CPS  
DT-135CPF, DT-200CPF

Pyrotronics 16p PROTECTIVE SYSTEMS

Models DT-135CPS, DT-200CPS  
Surface Mounted

Models DT-135-CPF, DT-200CPF  
Flush Mounted

## INTRODUCTION

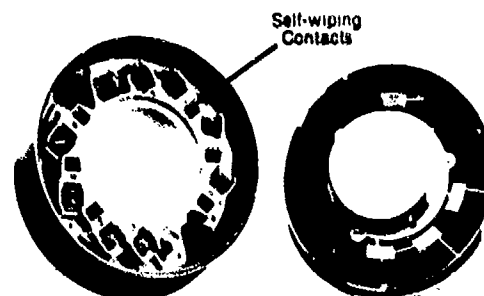
The Pyr-A-Larm Plug-In Thermal Fire Detectors are of the rate compensation/fix temperature type and are designed for use with the standard Pyr-A-Larm Detector base. Though the detector element is self-restoring, the detector locks in upon alarm, therefore it must be reset at the control panel. The detector is supplied in ratings of 135°F and 200°F. A lamp is located on the base to visually indicate the initiation of an alarm.

Underwriters' Laboratories, Inc., recommends the Thermal Detector be used to protect a maximum of 2,500 square feet. Job conditions and engineering judgment, however, often dictate closer spacing to provide faster detection. The Models, DT-135CPS, DT-200CPS, DT-135CPF and DT-200CPF are Underwriters' Laboratories, Inc., listed.

When subjected to a very slow heat rise the tubular shell and the interior struts lengthen at approximately the same rate. At the detectors' set temperature point of 135°F or 200°F, the interior struts are fully extended, thereby closing the contact points and initiating the alarm.

## PRINCIPLE OF OPERATION

Basically the detector consists of an aluminum tubular shell containing two curved expansion struts under compression fitted with a pair of normally open, opposed contact points which are insulated from the shell. The tubular shell and struts have a different coefficient of expansion. When subjected to a rapid heat rise the tubular shell expands and lengthens slightly. At the same time the interior struts lengthen but at a slower rate than the shell. The rapid lengthening of the shell allows the struts to come together, thereby closing the contact points and initiating the alarm.



Detector Base

Detector

DETECTOR REMOVED FROM BASE



**Pyrotronics**

A Baker Industries Company  
8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

August, 1974  
NEW ISSUE

Fig 6 Heat detectors - rate compensation

Pyrotronics 16p PROTECTIVE SYSTEMS



## Engineer and Architect Specifications

Pyrotechnics 16p PROTECTIVE SYSTEMS



Model DI-2S  
Surface Mounted



Model DI-2F  
Flush Mounted

### INTRODUCTION

The Pyr-A-Larm Models DI-2S and DI-2F fire detectors operate on a patented ionization principle. They respond to the first traces of fire in the form of visible smoke or invisible products of combustion. Heat or flame is not required to activate the detector.

### TECHNICAL DESCRIPTION

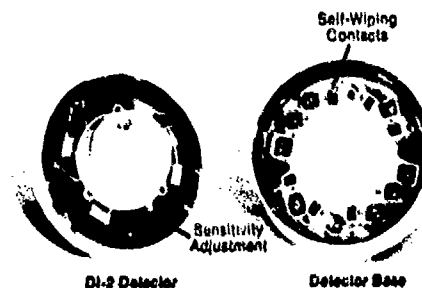
The detector contains two ionization chambers and a highly sensitive semiconductor amplifier-switching circuit. One chamber detects the presence of combustion products. The second chamber serves as a reference, to stabilize the detector's sensitivity for changes in environmental temperature, humidity and pressure. The detector has provision for measuring its sensitivity (using a Model SCU-8 Sensitivity Test Set) as well as provision for changing sensitivity.

The Model DI-2S is designed for surface mounting while the DI-2F is designed for flush mounting. Both models have an indicator lamp to indicate the alarm. A remote indicator lamp may be connected when the detector is concealed from view. The detector operates from a 22 Vdc source, provided by the Pyr-A-Larm control panel. The detector requires a very small standby current (less than 100 microamperes), which permits the use of a 2-wire detector circuit of #18 AWG wire, thereby reducing system installation costs. The Model DI-2S consists of a surface mounting base assembly and a plug-in detector head. The model DI-2F consists of a flush mounting base assembly, plug-in detector head, decorator ring and hung ceiling mounting plate. Each base may be attached to a standard 4" electrical box when conduit is used or may be used without box when local building codes permit. Pyrotechnics has available limited-energy shielded cable, without conduit for use where permitted by local codes.

The detector shell and base are fabricated of rugged polycarbonate material thereby eliminating any corrosion problems. The unit is of an off-white color and attractively styled to be unobtrusive and match most interiors. The DI-2F, flush mounting unit protrudes only 1" from the ceiling surface.

### APPLICATION DATA

These detectors are listed by Underwriters' Laboratories Inc., and although U.L. gives no specific spacing recommendation, the test spacing of 30 ft. (900 sq. ft.) may be used, if practicable, but only as a guide or starting point in a detector installation layout. The test fires conducted by U.L. were based on only one set of conditions, namely, a 15 ft. 9 in. high smooth ceiling, no air movement, and no physical obstructions between the fire source and detector. It should be realized that these are fairly ideal conditions for a symmetrical detector layout. For conditions other than the above, it is mandatory that engineering judgment be applied regarding detector location and spacing.



DETECTOR REMOVED FROM BASE



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

August, 1970

NEW ISSUE

Fig 7 Smoke detectors - ionization

Pyrotechnics 16p PROTECTIVE SYSTEMS



# Pyr-A-Larm

Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

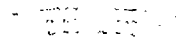
**Ionization  
Fire Detectors  
Delayed Action**  
MODELS DI-2DS & DI-2DF

Catalog  
Number  
**6101**

Pyrotechnics 16p PROTECTIVE SYSTEMS



Model DI-2DS  
Surface Mounted



Model DI-2DF  
Flush Mounted

## INTRODUCTION

The Pyr-A-Larm Models DI-2DS and DI-2DF fire detectors, with automatic delay, operate on a patented ionization principle. They respond to the first traces of fire in the form of visible smoke or invisible products of combustion. Heat or flame is not required to activate the detector.

## TECHNICAL DESCRIPTION

The detector contains two ionization chambers and a highly sensitive semiconductor amplifier-switching circuit. One chamber detects the presence of combustion products. The second chamber serves as a reference, to stabilize the detector's sensitivity for changes in environmental temperature, humidity and pressure. The detector has provision for measuring its sensitivity (using a Model SCU-8 Sensitivity Test Set), as well as provision for changing sensitivity.

Built into the detector is a circuit that automatically delays operation of the unit for a period having a range of 15 to 30 seconds. This feature is designed for special applications where momentary but harmless products of combustion may be present (As an example, this could be a small office with personnel expected to light pipes, cigars, etc.)

In addition, a function selector switch is provided to change the detector to a "no delay" operating mode, if desired.

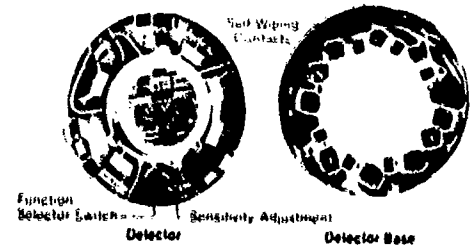
The Model DI-2DS is designed for surface mounting while the DI-2DF is designed for flush mounting. Both models have an indicator lamp to indicate the alarm. A remote indicator lamp may be connected when the detector is concealed from view. The detector operates from a 24 Vdc source, provided by the Pyr-A-Larm control panel. The detector requires a very small standby current (less than 100 microamperes), which permits the use of a 2-wire detector circuit of #18 AWG wire, thereby reducing system installation costs. The Model DI-2DS consists of a surface mounting base assembly and a plug-in detector head. The model DI-2DF consists of a flush mounting base assembly, plug-in detector head, detector ring and hung ceiling mounting plate. Each base may be attached to a 4" octagonal electrical box when conduit is used or may be used without box when local building codes permit. Pyrotechnics has available limited-energy shielded cable, without conduit for use where permitted by local codes.

The detector shell and base are fabricated of rugged polycarbonate material, thereby eliminating any corrosion problems. The unit is of an off-white color and attractively styled

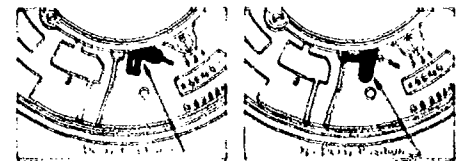
to be unobtrusive and match most interiors. The DI-2DF, flush mounting unit protrudes only 1 1/4" from the ceiling surface.

## APPLICATION DATA

These detectors are listed by Underwriters' Laboratories Inc., and although U.L. gives no specific spacing recommendation the test spacing of 30 ft (900 sq ft) may be used, if practicable, but only as a guide or starting point in a detector installation layout. The test fires conducted by U.L. were based on only one set of conditions, namely a 15 ft 9 in high smooth ceiling, no air movement and no physical obstructions between the fire source and detector. It should be realized that these are fairly ideal conditions for a symmetrical detector layout. For conditions other than the above it is mandatory that engineering judgment be applied regarding detector location and spacing.



## DETECTOR REMOVED FROM BASE



## FUNCTION SELECTOR SWITCH



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

October, 1974

Supersedes sheet dated 1 72

Fig 8 Smoke detectors - ionization

Pyrotechnics 16p PROTECTIVE SYSTEMS



## General

The smoke detector is used with the W939, W940A, or other UL listed compatible Fire Alarm Panels. It is designed for flush or surface mounting used with or without a 4 x 4 in. (102 x 102 mm) electrical box, as local codes and ordinances dictate. The TC100A Ionization Smoke Detector is UL listed, ULC listed, and Factory Mutual approved.

The detector circuitry is completely solid-state with two ionization chambers, comparator/switching circuit, and an easily seen light-emitting diode alarm indicator. One of the ionization chambers senses combustion products and the other serves as a reference to compensate for changes in tempera-

ture, humidity, pressure and velocity. The sensitivity is calibrated at the factory and field adjustment is normally

not required. For special applications a three-position sensitivity adjustment switch is provided.

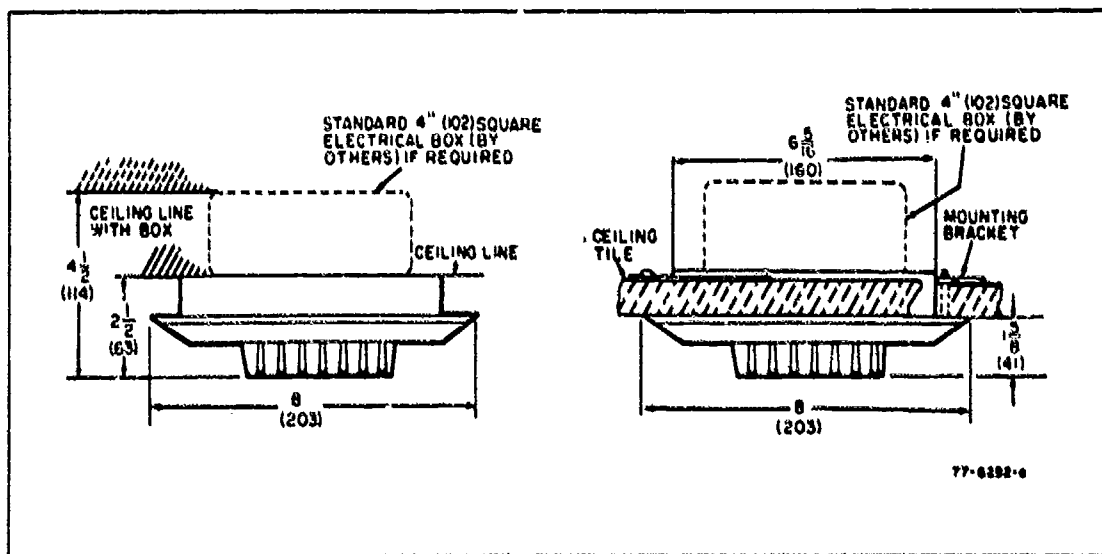


FIG. 1. TC100A APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)

Rev. 9-77  
D.L.

Form Number **77-6292**  
Copyright © 1977

Fig 9 Smoke detectors - ionization



# Pyr-A-Larm®

Early Warning Fire Detection and Alarm Systems

## Photoelectric Fire Detector

Catalog  
Number  
1115  
(1975)

Engineer and Architect Specifications

MODEL DPS-1

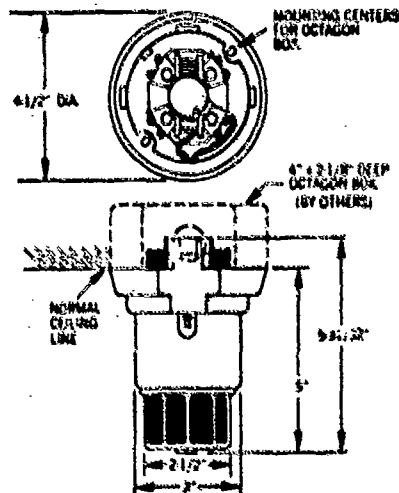
Pyrotechnics 16p PROTECTIVE SYSTEMS



### INTRODUCTION

The Pyr-A-Larm detector, Model DPS-1, operates on the photoelectric principle. It responds directly to visible smoke concentrations of 1/2% per foot. It is recommended for use in areas where it is not practical to employ the ionization type detectors due to high ambient concentrations of combustion products (in garages, furnace rooms, manufacturing areas having combustion producing equipment such as welding). In addition, it may be desirable to use the photoelectric detector in areas where the material expected to burn would produce very dense visible smoke.

### MOUNTING DATA



### ENGINEERING DATA

The photoelectric detector employs the Tyndall principle. A light source and a photocell are arranged in a labyrinth chamber in such a manner that no direct light and practically no reflected light can reach the photocell. Smoke particles entering the chamber are illuminated and the scattered light from such particles reach the photocell. This generates a voltage which is amplified by a transistor circuit, causing the ignition of a cold cathode tube that initiates the alarm. The light source is a gas filled flash tube, especially developed for this purpose, which generates a high intensity light flash every 2 to 3 seconds. In order to initiate an alarm, at least two light flashes are necessary, e.g. a smoke concentration must be present in the labyrinth for at least 5 to 10 seconds. Alarm activation by ambient light (illumination, lightning, welding operations, etc.) or by short temporary smoke concentrations are therefore excluded.

The detector contains a photoelectric cell and a flash tube in a labyrinth chamber, a transistor amplifier, gate circuits and a cold cathode tube. The current consumption per detector is approximately 50 microamps, and it is, therefore, possible to connect up to 5 detectors per zone. The detector sensitivity is expressed in percent per foot of light obscuration caused by smoke.

The detector contains no moving parts subject to wear. Service life of the light source exceeds 10 years. The detector is supervised so that failure of the light source or the sensing amplifier will cause an alarm signal. The detector is fabricated with corrosion resistant materials.



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

February, 1977

Supersedes Sheet dated 7/72

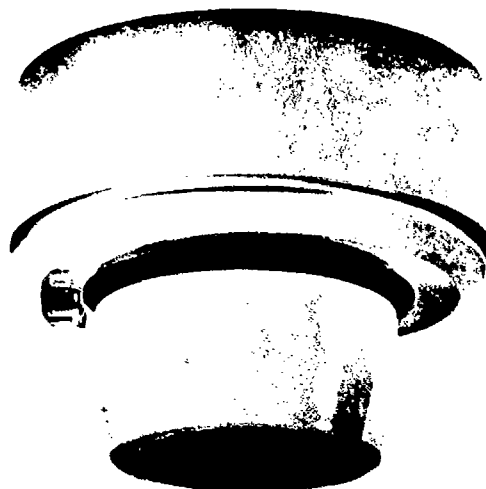
Fig 10 Smoke detectors photoelectric



Engineer and Architect Specifications

MODEL DS-2

Pyrotechnics 16P PROTECTIVE SYSTEMS



MODEL DS-2

#### INTRODUCTION

The Pyr-A-Larm Model DS-2 Smoke Detector operates on the photoelectric principle. It responds directly to visible smoke concentrations of 1.2% per foot obscuration. It is recommended for use in areas where it is not practical to employ the ionization type detectors due to high ambient concentrations of combustion products (in garages, furnace rooms, manufacturing areas having combustion producing equipment such as welding). In addition it may be desirable to use the photoelectric detector in areas where the material expected to burn will produce visible smoke.

#### TECHNICAL DESCRIPTION

The Model DS-2 operates on the light-scattering Tyndall principle. An LED and a photo-cell are arranged in a labyrinth so that light can only fall onto an opto-electrical transducer when scattered by smoke particles. When a preset threshold is exceeded, a voltage is generated which is amplified by a transistor circuit, initiating the alarm. Upon operation the detector "locks-in". When the smoke particles have cleared from the detector it can be reset from the control panel.

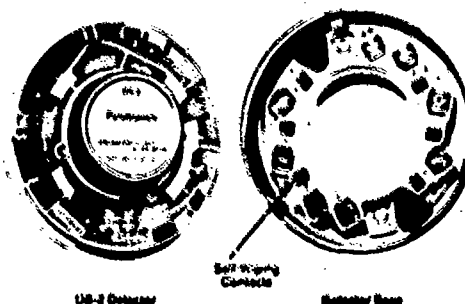
The Model DS-2, which is designed for surface mounting only, consists of a mounting base assembly and a plug-in detector head and is fitted with an indicator lamp to indicate the alarm. A remote indicator lamp may be connected when the detector is concealed from view.

The detector operates from a 22 Vdc source, provided by the Pyr-A-Larm control panel. The detector requires a very small standby current (less than 150 microamperes), which permits the use of a 2-wire detector circuit of #18 AWG wire, thereby reducing system installation costs. Pyrotechnics has limited-energy shielded cable available for use where conduit is not required by local codes.

The detector shell and base are fabricated of rugged polycarbonate material, thereby eliminating any corrosion problems. The unit is off-white in color and attractively styled to be unobtrusive and match most interiors.

#### APPLICATION DATA

No more than twenty (20) Model DS-2 detectors are to be used on any detecting circuit. Installation of photoelectric detectors should only be made after a careful evaluation has been made as to the shape of the hazard, its contents, air movements, and the location of air conditioning inlets and exhaust outlets. Smoke particles tend to stratify at different levels near the ceiling, based on ambient temperatures, ceiling configuration and any air movement. It is recommended therefore, that tests be made and readings taken before installation to assure optimum placement of the



DETECTOR REMOVED FROM BASE



**Pyrotechnics**

A Baker Industries Company  
8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

February, 1976  
NEW ISSUE

Fig 11 Smoke detectors - photoelectric

Pyrotechnics 16P PROTECTIVE SYSTEMS



## General

The TC803A Photoelectric Smoke Detector is used with ALPHA/DELTA 1000, W939, W940, or other UL listed compatible fire alarm control units. It is designed for surface mounting. The TC803A mounts on a 4-incl. square or octagonal electrical box (supplied by others) as local codes and ordinances dictate.

The TC803A is UL listed as an automatic smoke and fire detector for open area protection. The detector will alarm when smoke in its chamber reaches the fixed sensitivity setting of 1.5 percent (typical). A unique rate compensation circuit increases detector sensitivity upon a rapid buildup of smoke. One model of the detector also contains a thermostat that will alarm when the temperature, at the detector,

reaches 135 F (57 C). A relay within each detector will energize as the result of either alarm and its contacts can be

used to activate alarm indicating devices directly or through auxiliary equipment.

## Features

- Rate-compensated fixed sensitivity calibration.
- Red light emitting diode (LED) light source with 40 year rated life.
- Red LED alarm indicator lamp.
- Detection chamber is exposed for optimum smoke entry capability.
- Long term stability, low current consumption, and RF and transient protection.
- One set of SPST N.O. alarm contacts.
- Two sets of accessory SPDT alarm contacts.
- Built-in functional test capability.
- UL listed.

## Specifications

**MODELS**  
 TC803A1006 Photoelectric Smoke Detector.  
 TC803A1014 Photoelectric Smoke Detector with 135 F (57 C) heat detector.

**POWER REQUIREMENTS**  
 17-29.7v DC (24v DC nominal).

**STARTUP CURRENT**  
 0.025 amp for approximately two minutes.

**NORMAL CURRENT**  
 0.005 amp at 77 F (25 C).

**ALARM CURRENT**  
 0.035 amp.

**ACCESSORY CIRCUIT**  
 2 amp at 30v DC and 0.5 amp at 125v AC.

**DETECTOR COVERAGE**  
 Maximum recommended detector coverage is 900 sq ft (83.6 m<sup>2</sup>) under ideal

conditions (15 foot (4.6m) room height, smooth ceiling, no air movement). This coverage must be reduced when applied in rooms with high ceilings or large air movements. See 77-6116 Application Manual or NFPA 72E for details on smoke detector placement.

**THERMAL BACKUP**  
 135 F (57 C).

**LAMP LIFE**  
 Light emitting diode rated at 40 years.

Fig 12 Smoke detectors - photoelectric



# **PYRA-LARM®** Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

## Flame Detectors Infrared Type

MODELS DF-1S & DF-1F

Catalog  
 Number  
**6120**

### INTRODUCTION

The Pyra-Larm Models DF-1S and DF-1F flame detectors respond directly to the presence of flame. They sense the infrared radiation emanating from flames which must be modulated (fluctuating) of the flame and must be sustained for at least 5 seconds or 20 seconds (depending on detector setting). The detector is therefore not responsive to constant infrared radiation or to short fluctuating phenomena.

The flame detector is intended to protect hazards where the anticipated fires will develop quickly with little or no incipient or smoldering stages where ignition is almost instantaneous, e.g., combustible liquids, combustible gases, loose cotton, etc. The flame detector is not recommended for protection against incipient and smoldering stage fires. These are better protected by the ionization detector.

The flame detector is best suited for direct equipment or process protection and for use on high ceilings.

### TECHNICAL DESCRIPTION

The detector consists of a lead sulfide photoconductive cell which becomes activated for long response to a flame. A voltage is generated by the cell and amplified by a transistor amplifier/oscillator circuit. The oscillator output voltage is used to lock in the alarm in a manner similar to that of the ionization detector.

The detector incorporates a test position switch for selecting any combination of two sensitivity settings and two delay settings.

The Model DF-1S is designed for surface mounting while the DF-1F is designed for flush mounting. Both models have an indicator lamp to indicate the alarm. A remote indicator lamp may be connected when the detector is concealed from view. The detector operates from a 24 VDC source provided by the Pyra-Larm control panel. The detector requires a very small standby current less than 100 microamperes which permits the use of a 2-wire detector circuit at 24 VDC and thereby reducing system installation costs. The Model DF-1S con-

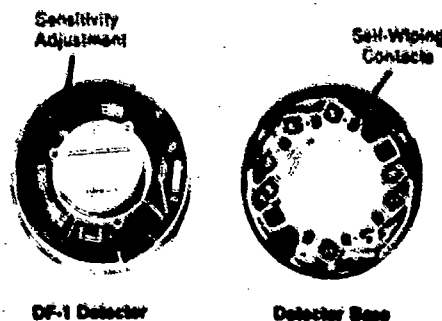
sists of a surface mounting base assembly and a plug-in detector head. The Model DF-1F consists of a flush mounting base assembly, plug-in detector head, detector ring and flush ceiling mounting plate. Each base may be attached to a standard electrical box when conduit is used or may be used without box when local building codes permit. Pyrotechnics has available limited-energy shielded cable for use where conduit is not required by local codes.

The detector shell and base are fabricated of rugged polycarbonate material, thereby eliminating any corrosion problems. The unit is of an off-white color and attractively styled to be unobtrusive and match most interiors. The DF-1F flush mounting unit protrudes only 1" from the ceiling surface.

### APPLICATION DATA

The optimum ceiling height is 30-50 feet. The detector may be used on ceilings as high as 45 feet.

At the lowest ceiling heights, the 20 second settings should be used to minimize the possibility of unwanted alarms. On higher ceilings, the 5 second settings should be used to increase detector sensitivity.



**Pyrotechnics**

A United Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

January, 1974

NEW ISSUE

Fig 13 Flame detectors - Infrared



# Pyr-A-Larm®

Early Warning Fire Detection and Alarm Systems

## Flame Detectors

Engineer and Architect Specifications

MODELS DFS-3, DFS-10, DFS-30

Pyrotechnics 16P PROTECTIVE SYSTEMS



**Description**—The Pyr-A-Larm flame detectors respond directly to the presence of flame. They sense the infrared radiation emanating from flames which must be modulated (flickering of the flame) and must be sustained for at least 2, 10, or 30 seconds (depending on detector selected). Response to constant infrared radiation or to short flickering phenomena is, therefore, excluded.

The flame detector is intended to protect hazards where the anticipated fires will develop quickly with little or no incipient or smoldering stages; where ignition is almost instantaneous (e.g. flammable liquids, combustible gases, loose cotton fibre, etc.). The flame detector is not recommended for protection against incipient

and smoldering stage fires. This is better protected by the ionization detector. The Model DFS detectors are Factory Mutual approved.

The flame detector is best suited for direct equipment or process protection and for use on high ceilings. It should be used in combination with ionization detectors.

For detailed information refer to manual on "Application Data, Flame Detectors" (form B-100).

**Principles of Operation**—The detector consists of a silicon solar cell (photo-electric) located behind a convex infrared filter lens. In response to a flame, a voltage is generated by the cell and amplified by a 5 stage transistor amplifier-rectifier-integrator circuit. The integrator output voltage is used to activate a cold cathode tube which locks in the alarm in a similar manner to that of the ionization detector.

In contrast to the ionization detector, the flame detector draws a small operating current (45 microamperes) and thus a maximum of 5 flame detectors may be used per zone.

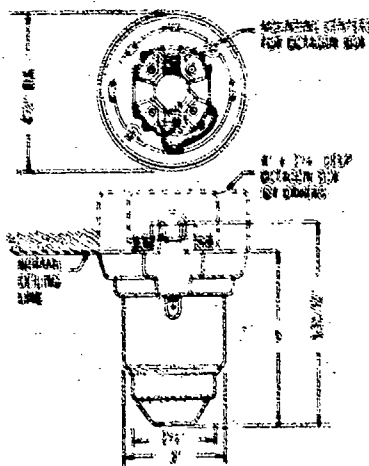
The detector operates in conjunction with the standard neon alarm indicator, located in the detector base. It may be installed in a standard ionization detector base or in a Pyr-A-Larm recessed ceiling fixture.

**DETECTOR MOUNTING HEIGHT**—When used for area protection, the following general rules apply. The optimum ceiling height is 30-50 feet. The detector may be used on ceilings as high as 85 feet.

At low ceiling heights, the 30 or 10 second detectors should be used to minimize the possibility of unwanted alarms. On high ceilings the 10 or 3 second detectors should be used to increase detector sensitivity.

The detector sensitivity is inversely proportional to the square of the distance from the fire source. Therefore, doubling the distance requires a four times larger fire for detection.

### MOUNTING DATA



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

May, 1973

Supersedes Sheet 0000 4772

Fig 14 Flame detectors - Infrared



**DESCRIPTION OF OPERATION**

Automatic Optical Integrity - AOi - is an extension of the optical integrity concept pioneered and perfected by Detector Electronics. AOi places important new capabilities at the disposal of the fire protection professional, and makes possible a higher degree of security for applications where fire hazard is an unavoidable risk in production processes.

AOi is an important step forward in ultraviolet fire protection. Developed and manufactured by Detector Electronics, it gives complete assurance that the entire fire detection system is fully operational and ready to respond to fire or explosion.

Automatic Optical Integrity means that the detector's optical surfaces as well as the associated electrical circuitry are continuously checked by a logic system in the R7302B Controller. It makes certain the ultraviolet sensing system is unimpaired and unobscured and that all sensing and alarm circuits are operational.

An important consideration with any ultraviolet fire detector is that a gradual buildup of contaminants - oil, gasoline, petro-chemicals, grime, salt, - on the lens surface will absorb ultraviolet radiation. When the buildup is heavy enough, the detector is blind.

The system consists of one or more C7050B's (up to eight Detectors) and the R7302B Controller.

The controller is in modular form and consists of electronics to process the detector signal, plus several switching relays. When one of the detecting units "sees" an amount of ultraviolet radiation greater than the sensitivity setting, one relay is energized immediately. If the ultraviolet level remains above the sensitivity setting, a second relay closes after a pre-determined (field adjustable) time delay. Should a system malfunction develop, a fault relay, which is part of the supervised circuitry, automatically indicates a problem.

The C7050B/R7302B combination provides the same instantaneous response to flame as other Det-Tronics models and features the following important advances:

\*AOi is Detector Electronics' trademark for its patented Optical Integrity systems.  
U.S. Pat. Number 3,652,186

Detector Electronics Corporation

**C7050B, R7302B Combination  
Ultraviolet Fire Detection System**

AOi System includes standard C7050B Detector plus the Det-Tronics 18 inch Instrument Rack Controller equipped with Digital Display for fault identification.

-A digital display located on the front of the R7302B Controller specifically identifies by code number, fault conditions that may develop in the C7050B Detector, the Controller itself, or any interconnecting wires. Should a fault occur, a monitoring relay with remote indication capability registers that fact, and simultaneously the exact nature of the fault is shown on the digital display. If the fault involves a reduction in the sensitivity of any detector for any reason, the display will also identify which detector or detectors are involved.

-Should any detector be suddenly blinded, as, for example, due to the rupture of an oil line, the AOi system will automatically produce a fault signal at the R7302B Controller. The AOi test sequence takes less than one second per detector.

-Gradual contamination of the C7050B Detector's optical surface will automatically produce a fault signal at the R7302B Controller, long before the detectors are rendered incapable of response to fire.

**Fig 15 Flame detectors - ultraviolet**



# DET — TRONICS

## SPECIFICATION DATA Ultraviolet Fire Detection

System - Featuring  
Optical Integrity



Using C7050B Detector, and  
R7300B or R7301B Controller

### SYSTEM DESCRIPTION

The Detector Electronics ultraviolet fire detector system has taken an important step forward in the dependability and reliability of the **total** system by the addition of the "oi" feature - optical integrity. Developed and manufactured by Detector Electronics it gives assurance that the entire fire detection system is fully operational and ready to respond to fire or explosion. See Figure 1.

With any ultraviolet fire detector, a buildup of contaminants such as oil, gasoline, petrochemicals, on the detector window absorbs ultraviolet radiation. Before "oi" a frequent check with a portable ultraviolet "flashlight" to simulate a fire was necessary to check the detector and the controller. It required two persons to conduct the test - one at the detector and the other at the controller.

The Detector Electronics "oi" system is a simple test method that can be performed by one person at the controller as often as required or desired. The use of the "flashlight" then is only needed to check sensitivity levels and the locations of the detectors periodically.

The "oi" system uses a special ultraviolet test lamp inside the detector housing, but optically isolated from the ultraviolet sensor. Placing the controller in bypass locks out the alarm circuits. Pushing the "oi" pushbutton on the controller turns on the test lamp in the detector housing. Ultraviolet radiation from the test lamp goes through the quartz window to the beveled ring and back through the window to the ultraviolet sensor. See Figure 2.

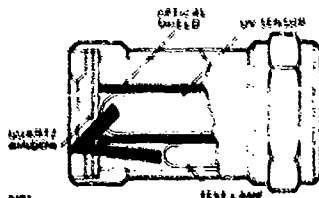


Figure 2-Cutaway View of C7050B Detector.

Light on the controller indicates the output relays respond which shows that the window is clean and the UV Sensor is operational. Lack of response indicates that the sensitivity is reduced due to contamination on the window, or electronic control problems. This is the optical integrity ultraviolet fire detection system.

Detector Electronics Corporation

"oi" is Detector Electronics' trademark for its patented  
Optical Integrity systems. U.S. Pat. No. 2,957,196

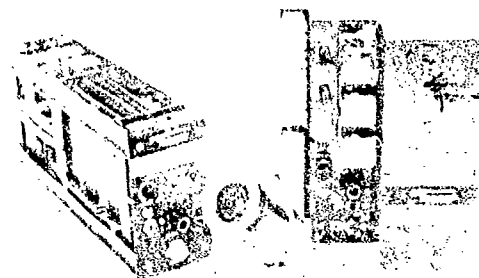


Figure 1-Detector Electronics Ultraviolet Fire Detection System with "oi".

The "oi" detector has an explosion-proof cylindrical housing of nickel-plated brass, stainless steel (303 or 316) or anodized copper-free aluminum. It resists shock and vibration. It may be mounted outdoors in direct sun because the detector is not sun sensitive, or anywhere indoors, even in high intensity lighting areas. It is available with swivel bracket with a 240 degree sweep adjustment or an optional quick-connect mounting for the quartz window and for looking inside mixers, kettles, conveyors and other inaccessible areas.

The "oi" detector works with either the R7300B or R7301B Controller. The R7300B Controller is a surface-mount unit for enclosures inside cabinets or cubicles. The R7301B Controller is a slot rack-mount unit that fits any standard 10 inch instrument rack enclosure. It is available with various options, including high-monitoring relays and automatic A/C/DC changeover. Either controller handles up to eight detectors.

### SPECIFICATIONS

#### SPECTRAL SENSITIVITY RANGE -

Det-Tronics oi ultraviolet fire detector responds to radiation in the range of 1850 to 2450 Angstroms. Detectors are not sensitive to direct or reflected sunlight or normal artificial light.

#### SENSITIVITY -

Controller sensitivity is field adjustable for 25, 50, 75 and 100 counts per second response, meaning that a reference flame (consisting of a gasoline fire generated from a one square foot surface) can be detected at distances ranging from 15 feet to greater than 45 feet.

Fig 16 Flame detectors - ultraviolet



**PYR-A-LARM®**  
Early Warning Fire Detection and Alarm Systems

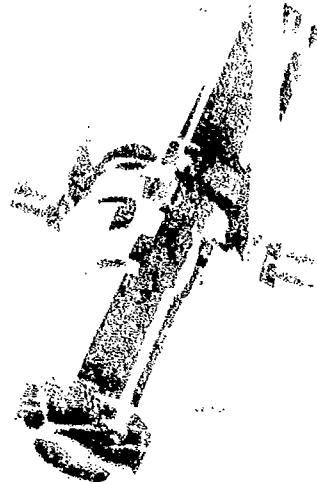
Engineer and Architect Specifications

# Unitized Flame Detector/Controller Ultraviolet Type

SERIES U-7600

Catalog  
Number  
**6140**

Pyrotechnics 16p PROTECTIVE SYSTEMS



## INTRODUCTION

The Pyr-A-Larm Ultraviolet Type, Unitized Flame Detector and Controller, Series U-7600 is a complete detection unit, incorporating all electronic and switching components in a single compact enclosure, together with a highly sensitive, reliable flame detector.

To increase application flexibility, the Series U-7600 Detector/Controller can also be used with the Model C-7050 detector serving as a remote sensor.

## APPLICATIONS

Hazardous Area Flash Fires	Compressor Stations
Gaseous Fuels	Metal Powders
Toluene Storage	Flammable Liquids
Gasoline Loading Terminals	Off Shore Oil Platforms
Pumping Stations	Munitions Production

Since the unit is insensitive to solar radiation and cannot be actuated by normal artificial lighting, it is ideal for either indoor or outdoor applications. Adverse weather conditions, such as wind, rain, and snow will not affect operation. Operating temperature range is from -40°F to +158°F (-40°C to +70°C). The U-7600 Series is particularly well suited for applications where Division I explosion proof enclosures are required for control and switching circuits.

The detector should not be used in the vicinity of gamma radiation or X-rays or where arc welding is performed. Special techniques must be followed when locating detectors to restrict these sources of radiation from the detector's cone of vision (90° spherical).

## TECHNICAL DESCRIPTION

The detector is essentially a Geiger-Mueller gas type cathode tube that is designed to detect flame-radiated rays in the extreme low (ultraviolet) end of the radiation spectrum, outside the range of human vision and at a wavelength 1850 to 2450 Angstroms (10,000 Angstroms is equal to 1 micron or .001 millimeters).

Radiation is not emitted continuously but in small bundles called photons. When a photon of ultraviolet radiation is seen by the detector tube cathode, electrons are drawn to the anode, causing a small flow of current which actuates the alarm circuit.

The unitized detector can be thought of as a normally open switch that is momentarily closed when ultraviolet radiation with a wavelength of 1850 to 2450 Angstroms enters the viewing window of the detector. With the closing of the circuit, the detector goes into alarm condition. Response is extremely fast, typically less than 25 milliseconds from an intense ultraviolet source. A LED is visible through the viewing window indicating detector actuation. The unit contains two independent relay actions, one responding instantaneously and a second that is field adjustable from 0 to 30 seconds for delayed action. Relay contacts are Form C, 10 amps, resistive. The detector/controller is available in a Nema 4 enclosure, Class I, Division I, Groups A, B, C, D, Class II, Division I, Groups E, F, and G. It is available in nickel plated brass, stainless steel or copper-free aluminum, and is bracket/swivel mounted for ease of installation. Two conduit entries are available, 1/2" NPS or 20 mm optional.



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NEW ISSUE

Fig 17 Flame detectors - ultraviolet

Pyrotechnics 16p PROTECTIVE SYSTEMS



Engineer and Architect Specifications

SERIES C-7037, C-7050

Pyrotechnics 16p PROTECTIVE SYSTEMS



Series C-7037



Series C-7050 w/Swivel Mount

#### INTRODUCTION

The Pyr-A-Larm Flame Detectors, Ultraviolet Type Series C-7037 and C-7050 are intended for use with a controller assembly to form a complete fire detection system. These systems, each incorporating one or more detectors (8 maximum), provide excellent protection for high risk hazards where there is a need for highly reliable and instantaneous response to flame.

Series C-7037 detectors are for use with R-7300 and R-7301 Controllers. Series C-7050 miniature detectors are for use for R-7300, R-7301, and R-7302 Controllers.

#### APPLICATIONS

Hazardous Area Flash Fire  
Gasoline Fuels  
Toluene Storage  
Gasoline Loading Terminals  
Pumping Stations

Compressor Stations  
Metal Powders  
Flammable Liquids  
Off Shore Oil Platforms  
Munitions Production

Since the units are insensitive to solar radiation and cannot be actuated by normal artificial lighting, they are ideal for either indoor or outdoor applications. Adverse weather conditions, such as wind, rain, and snow will not affect operation. Operating temperature range is from -40°F to +170°F (-40°C to +77°C). The detectors are particularly well suited for applications where Division I explosion proof enclosures are required.

The detectors should not be used in the vicinity of gamma radiation or X-rays or where arc welding is performed. Special techniques must be followed when locating detectors to restrict these sources of radiation from the detector's cone of vision (90° spherical).

#### TECHNICAL DESCRIPTION

The detector is essentially a Geiger-Mueller gas type cathode tube that is designed to detect flame-radiated rays in the

extreme low (ultraviolet) end of the radiation spectrum, outside the range of human vision and at a wavelength of from 1850 to 2450 Angstroms (10,000 Angstroms is equal to 1 micron or 0.01 millimeters).

Radiation is not emitted continuously but in small bundles called photons. When a photon of ultraviolet radiation is seen by the detector tube cathode, electrons are drawn to the anode, causing a small flow of current which actuates the controller alarm circuit.

Response is extremely fast, typically less than 25 milliseconds from an intense ultraviolet source.

The C-7037 detector is supplied in an aluminum housing which is rated Class I, Division 1 Group D, Class II Division 1, Groups E, F, and G. The C-7050 miniature detector has Class I, Division 1, Groups A, B, C, and D and Class II, Division 1, Groups E, F, and G ratings.

#### OPTICAL INTEGRITY (For Series C-7050 detectors only)

Optical integrity gives complete assurance that the entire fire detection system is fully operational and ready to respond to fire or explosion. Most important, it means that the detector's optical surfaces are clean and that the associated electrical circuitry can be completely checked, manually or automatically, either from a remote or local test station, or from a system controller. It also makes certain that the ultraviolet sensing system is unimpaired and that all sensing and alarm circuits are operational.

An important consideration with any ultraviolet fire detector is that a gradual buildup of contaminants (oil, gasoline, petrochemicals, grime, salt) on the lens surface will absorb ultraviolet radiation. When the buildup is heavy enough, the detector is blind, even though virtually undetectable to the human eye.



**Pyrotechnics**

A Baker Industries Company  
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February, 1977

NEW ISSUE

Fig 18 Flame detectors - ultraviolet



# Detector Heads

The Model 564 and 567 Edison U/V Detector Heads consist of a plug-in solid state module mounted in a housing assembly. The housing contains a quartz window which passes U/V radiation to the sensor. The sensor has a spectral response of 1900 to 2600 Angstrom units. Model 564 has a watertight and dust-tight housing (NEMA Class 4, UL Indoor/Outdoor). Model 567 is rated explosion-proof (NFPA and Class I, Division I, Group D) and dust ignition proof (NFPA Class II, Division I, Groups E, F & G) — as well as watertight and dust tight (NEMA 4 and UL Indoor/Outdoor).

The plug-in module contains the U/V detector, the source, power and signal transformers and a printed circuit board on which are mounted a solid state signal amplifier and associated circuitry. The plug-in receptacle in the housing base is provided with four screw terminals for wiring to the control unit.

Swivel mount, part number 43903, may be used to rotate the alignment of the viewing axis.

## How to order

Determine the number and type of detector heads — Model 564 or Model 567 — required to protect the area. Plan your installation using a sufficient number of heads so placed that no point will extend beyond the viewing field nor beyond the distance calculated for the flame source. Refer to Figure 1.

Part number coding shown below completely identifies the detector heads.

564 — 0 0 0 1 1  
 Manufacturer Series  
 Approvals shown on nameplate (See Table 1)  
 No Significance  
 Model Number

567 — 0 0 0 1 3  
 Manufacturer Series  
 Approvals shown on nameplate (See Table 1)  
 No Significance  
 Model Number

TABLE 1

Approvals Shown	4th Dash No.
FM	0
FM UL*	1

\*Detector heads with this name plate are intended for use with Control Units part numbers 613-001X1, -011X1, -021X1 and -031X1 only and will not be supplied with systems using other Control Units.

## SPECIFICATIONS

### Service Ratings:

Model 564: . . . . . NEMA 4 — Watertight and Dust-tight  
 UL — Indoor/Outdoor

Model 567: . . . . . NEMA 4 — Watertight and Dust-tight  
 UL, NFPA — Class I, Division I,  
 Group D — Explosion-proof; Class II,  
 Division I, Groups E, F, G — Dust-  
 ignition proof  
 UL — Indoor/Outdoor

Spectral Response: . . . 1900 to 2600 Angstrom units

### Viewing Field:

Model 564: . . . . . 90°

Model 567: . . . . . 80°

Ambient Temperature: — 40° to 165°F (— 40° to 74°C)

### Weights:

Model 564

Model 567

Installed: . . . . . 4 lbs.

6 lbs.

Shipping: . . . . . 5 lbs.

7 lbs.

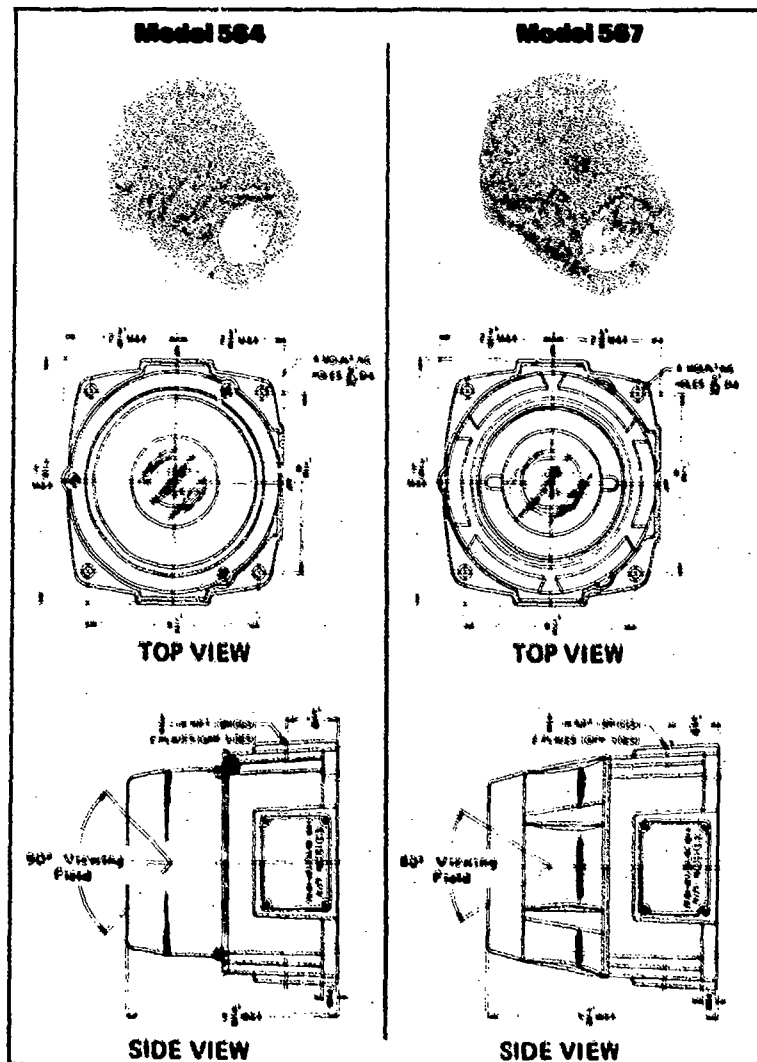
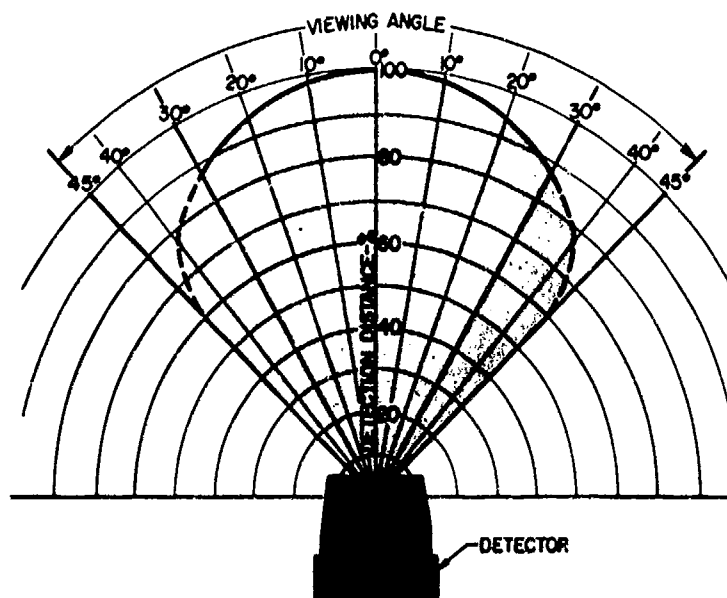


Fig 19 Flame detectors - ultraviolet (McGraw-Edison Co.)



FIGURE 1

FLAME DETECTION DISTANCE vs VIEWING ANGLE  
U/V FIRE DETECTOR  
MODELS 564 AND 567



DETECTION DISTANCE FOR ONE SECOND AVERAGE RESPONSE TIME

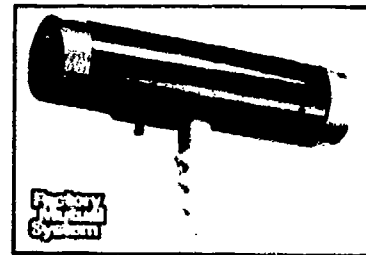
FLAME TYPE	CENTER OF CONE	30° OFF CENTER CONE
PROPANE, DIFFUSION FLAME		
1 1/4" HIGH, .021 ORIFICE	40 INCHES	35 INCHES
3" HIGH, .021 ORIFICE	41 INCHES	36 INCHES
4" HIGH, .021 ORIFICE	44 INCHES	38 INCHES
5" HIGH, .021 ORIFICE	49 INCHES	43 INCHES
GASOLINE		
12" SQUARE PAN	30 FEET	26 FEET
5" DIA. PAN	10 FEET	8 FEET
HYDROGEN, DIFFUSION FLAME		
1" HIGH, .062 ORIFICE	18 INCHES	16 INCHES
TURBINE OIL #9 (CHEVRON)		
12" SQUARE PAN	19 FEET	16 FEET
NATURAL GAS		
30" HIGH, 1/8" ORIFICE	30 FEET	26 FEET

NOTE: GREATER DISTANCES ARE ATTAINABLE FOR LONGER RESPONSE TIMES

### Portable Test Unit

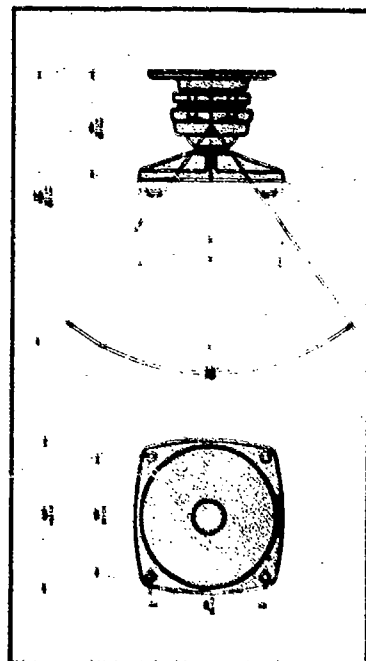
Although Edison U/V fire detectors have internal test sources and self checking circuits, testing with the P.T.U. further enhances system reliability by checking the detector heads externally.

The P.T.U. Part No. 43808 is an external test source for all Edison U/V Fire Detectors. This device is portable, battery operated and designed for use in hazardous locations, Class I, Division I, Groups B, C, D, Class II, Division I, Groups E, F, G. The P.T.U. will activate Edison U/V fire detectors at distances up to 30 feet. The energy source for the P.T.U. is eight (8) size "D" 1.5 volt batteries.



### Swivel Mount

Swivel Mount, Part No. 43903, mates with the base of the Models 564 and 567 Edison U/V Detector Heads and permits convenient rotation of the alignment of the viewing axis. The axis may be rotated thru an included angle of 70° and locked in place after sighting.



McGRAW-EDISON COMPANY  
Edison Electronics Division

General Electric Building, Syracuse, New York 13202-1000 • TEL: 443-1000 • FAX: 443-1747

Publication No. 3127A

March 1, 1974

Printed in U.S.A.

Fig 20 Flame detectors - ultraviolet



APPENDIX B

DETECTION SYSTEM PANELS AND POWER SUPPLY UNITS

REPRESENTATIVE SYSTEMS AND EQUIPMENT



## EDISON U/V Fire Detection Systems

For many years, Edison U/V self-contained fire detectors have monitored areas from fuel loading docks, offshore oil rigs, storage tanks, natural gas and oil pipelines, airport refueling areas, warehouses to hydrogen transfer and storage facilities. Now there are two new approaches to fire surveillance systems for industrial applications. The Edison U/V Type 613 and Type 616 systems. The sensor utilized in these systems is not new.

Both systems have been built upon the Edison pioneered sensor which "sees" the ultraviolet radiation emitted from all types of flames and yet are completely insensitive to visible and infra-

red radiation, and unresponsive to temperature, sunlight and other common sources of illumination. The systems have been field tested to overcome the problems associated with devices that cause false alarms or fail to react fast enough when the possibility of flash fires is present.

The U/V Type 613 and U/V Type 616 systems provide supervised fire detection capabilities for one to eight monitored areas. Each detector head is unresponsive to solar radiation and has built-in flame simulation, a U/V radiation source for continuously checking the complete system twice each second. The system's ability to respond is moni-

tored so that should the main power source or a circuit failure occur, or a valid flame simulation check not occur, there will be a "no confidence" or trouble alarm indication.

To check external alarm devices and extinguishing zone circuits, the systems have a manual test provision which continuously energizes the U/V flame simulation sources and a fire alarm condition results. This must be reset manually.

Edison offers a choice of two systems, Type 613 or Type 616, both of which can use from one to eight Model 564 or 567 U/V Fire Detector Heads. The detector heads may be located up to 1500 feet from the control unit.

TYPE 613

TYPE 616

Fig 21 Detector controllers



# TYPE 613

## CONTROL UNIT

The Model 613 Control Unit contains the electronic circuitry assembled on plug-in modules with printed wiring, switches, indicator lights, fuses, a voltage regulator and terminals for connecting all external wiring.

The control unit contains the system's electronics. Its enclosure is suitable for indoor or outdoor applications. Indicator lights identify the presence of a FIRE SIGNAL, the FIRE ALARM, TROUBLE ALARM, TROUBLE ALARM POWER, TROUBLE ALARM SILENCED. DETECTOR indicator lights also identify the active detector heads and pin point the head causing the fire signal or trouble alarm.

A lock guards against unauthorized personnel intruding or tampering with the modules, their adjustments and associated components or gaining access to the TEST, RESET or TROUBLE ALARM SILENCED switches as well as the internal fuses. Additional test and reset switches may be connected remotely. The system is designed to operate on standard single-phase, three wire commercial power from two power inputs, one of which is supervised.

In the control unit up to six plug-in modules are mounted — a POWER MODULE, an ALARM MODULE and up to four SUPERVISORY MODULES. Only one supervisory module is required for each pair of detector heads. The modules are keyed so that they cannot be installed in an incorrect position.

## POWER MODULE

The nucleus of the self-checking system is the solid state flasher circuit located in this module. During normal system operation a U/V source in each detector head is energized twice a second from the flasher. The module also furnishes the low DC voltage required by the alarm and supervisory modules. A malfunction within the power module will result in a trouble alarm.

## ALARM MODULE

The alarm module contains two alarm relays — the master fire alarm and master trouble alarm relays — solid state components for an adjustable alarm delay circuit. The delay is field adjustable from  $\frac{1}{2}$  to 6 seconds and is provided to minimize the possibility of fire alarms resulting from transient U/V radiation, such as lightning.

During normal operation the master fire alarm relay in the alarm module is unenergized and the master trouble relay is energized.

## SUPERVISORY MODULE

The supervisory module contains the balance of the electronic components required for fire detection including two

sets of relays. Two fire detector heads can operate from one supervisory module. If only one head is required, its signal wiring can be connected to both inputs.

During normal system operation the U/V source in each detector head is energized twice each second from the solid state flasher circuit in the power module. This causes the test sources to emit flashes of U/V radiation which, in turn, cause the U/V detectors to conduct. These pulses are directed to the supervisory module and cause the associated transistors to conduct at the same rate. Conduction at this rate is sufficient to energize the trouble relay circuit but is not sufficient to cause fire relay circuit to become de-energized. Thus, during normal operation both pairs of relays are energized. In this condition the detector indicator lights associated with each supervisory module are lighted. Under normal conditions these relays keep the master fire alarm relay in the alarm module from being energized and the master trouble alarm relay energized.

Supervisory modules are available with sensitivity controls. Each detector can be field adjusted to the desired fire detection level. The control reduces the sensitivity level of a detector to 35%.

## SYSTEM POWER

Input power for the system may be obtained from two separate sources. One powers the alarm, power and supervisory modules; the external fire alarm circuit; and auxiliary equipment. The other source powers the trouble alarm circuit and the trouble alarm light.

Failure of the main power or associated components or wiring will result in a trouble alarm signal — the TROUBLE ALARM light on. Failure of the trouble alarm power causes the TROUBLE ALARM POWER indicator light to go out and the master trouble relay to drop out and its contacts to close. These may be used in a trouble alarm circuit for an external audible device.

## OPTIONS

### Auxiliary Bypass Circuit

As an option, systems are available with an auxiliary circuit providing contact closure on fire but not on manual test.

Units without the bypass circuit option will energize the auxiliary equipment.

### Sensitivity Adjustment

Supervisory modules are available with sensitivity controls as an option. With this option each detector head can be field adjusted to increase the fire intensity required to obtain a fire signal.

## INSTALLATION

The screw type terminals in the control unit permit connection to the detector heads and to almost any type of external alarm devices such as audible signals, warning lights, automatic shut-down or other auxiliary equipment. Two separately fused fire alarm and auxiliary circuits are provided.

Terminals are also provided for connecting test and reset switches remotely.

## TYPE 613

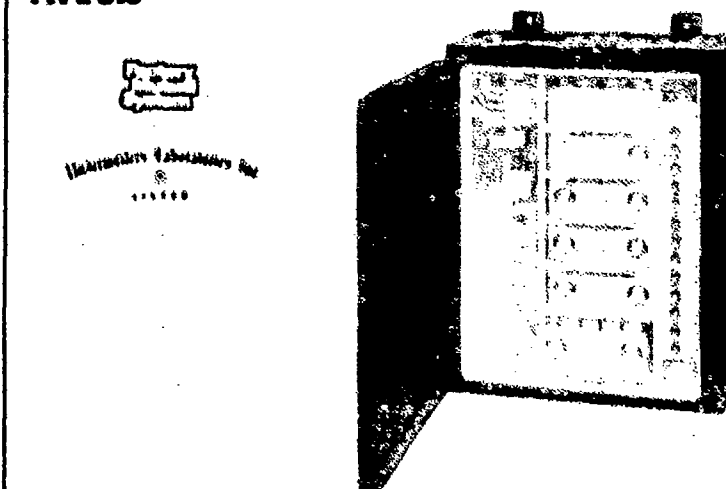
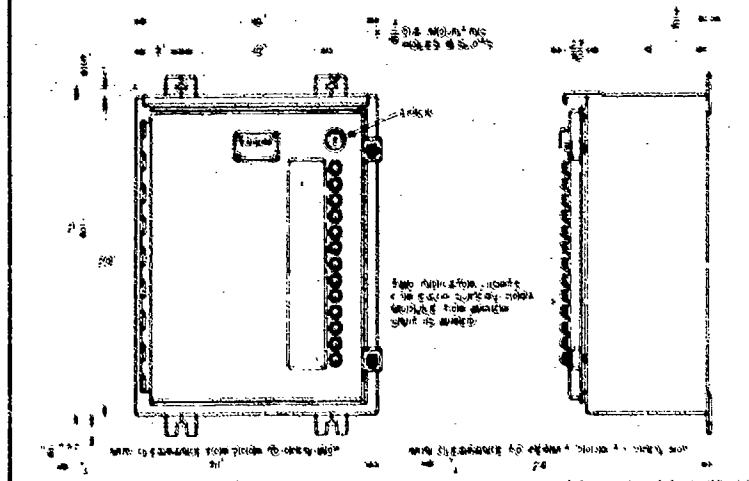


Fig 22 Detector controllers (McGraw-Edison Co.)



- **UL and FM approved**
- **Flame simulation for continuous self checking**
- **Solar blind**
- **Fast response**
- **Fire, auxiliary and trouble circuits**
- **Voltage regulation**
- **Wide cone of vision**
- **Monitors up to eight detectors up to 1500 feet**
- **Trouble Alarm**
- **Adjustable time delay**
- **Adjustable sensitivity control**
- **Solid state components**
- **Rugged plug-in modules**
- **Easy to install and maintain**

<b>Service Ratings</b>	<b>NEMA 3, 12 — Weather-proof and Dust Tight UL — Indoor/Outdoor</b>
<b>Operating Voltage:</b>	<b>See Table 2</b>
<b>Power Consumption:</b>	<b>65 VA excluding loads</b>
<b>Connected Load Ratings:</b>	
<b>Fire Alarm &amp; Auxiliary Circuit Combined</b>	<b>3 amp. inductive, 5 amp. resistive @ 120 VAC</b>
<b>Trouble Alarm Circuit</b>	<b>3 amp. inductive, 5 amp. resistive @ 120 VAC</b>
<b>Alarm Delay</b>	<b>Adjustable from 1/2 to 6 seconds after flame signal</b>
<b>Ambient Temperature</b>	<b>- 40° to 165°F (- 40° to 74°C)</b>
<b>Weights:</b>	
<b>Installed:</b>	<b>63 lbs. max.</b>
<b>Shipping:</b>	<b>98 lbs. approx.</b>



Determine the number and type of detector heads – Model 564 or Model 567 – required to protect the area. Plan your installation using a sufficient number of heads so placed that no point will extend beyond the viewing field nor beyond the distance calculated for the flame source. Refer to figure 1, on page 8.

Part number coding shown below completely identifies the Model 613 control unit.

- Manufacturer's Series
- Fire detection capability (Table 1)
- Operating voltage (Table 2)
- Options (Table 3)
- Model number

**TABLE 1**  
**Fire Detection Capability**

Fire Detection Capability	Supervisory Modules supplied	4th Dash Number
2	1	3
4	2	6
6	3	8
8	4	9

2nd Dash Number
1
2
3
4
5
6

\*Only this operating voltage has been tested and approved by Underwriters' Laboratories.

	1st and 2nd Dash Number
Name	00
Sensitivity control	01
Auxiliary bypass circuit control on test	02
Cables 01 and 02	03

-97-



# TYPE 616

## CONTROL UNIT

The Model 616 Control Unit contains the electronic circuitry assembled on plug-in modules with printed wiring, switches, detector and zone indicator lights, zone relays, fuses, a voltage regulator and terminals for connecting all external wiring.

The control unit contains the system's electronics. Its enclosure is suitable for indoor or outdoor applications. Indicator lights identify the presence of a FIRE SIGNAL, FIRE ALARM, CONFIDENCE POWER, NO CONFIDENCE as well as energization of the EXTINGUISHER circuit and the condition of the CONFIDENCE OVERRIDE and EXTINGUISHER OVERRIDE circuits. Light DETECTOR indicator lights identify the active detector heads and pin point the head causing the fire signal or trouble alarm. Light ZONE indicator lights identify the extinguisher circuit energized. The zone indicator lights remain on until manually reset. Individual zone relays, one for each detector, permit extinguisher circuits to be connected for cross zoning.

A lock guards against unauthorized personnel intruding or tampering with the modules, their adjustments and associated components or gaining access to the TEST, RESET, CONFIDENCE ALARM SILENCED or EXTINGUISHER OVERRIDE switches. Additional test and reset switches may be connected remotely. The system is designed to operate on standard single phase, three wire commercial power from two power inputs, one of which is supervised.

In the control unit up to six plug-in modules are mounted — a POWER MODULE, an ALARM MODULE and up to four SUPERVISORY MODULES. Only one supervisory module is required for each pair of detector heads. The modules are keyed so that they cannot be installed in an incorrect position. Power, Alarm and Supervisory Modules are interchangeable with those used in the Model 613 Control Unit.

## POWER MODULE

The nucleus of the self-checking system is the solid state flasher circuit located in this module. During normal system operation a U/V source in each detector head is energized twice a second from the flasher. The module also furnishes the low DC voltage required by the alarm and supervisory modules. A malfunction within the power module will result in a trouble alarm.

## ALARM MODULE

The alarm module contains two alarm relays — the master fire alarm and master trouble alarm relays — solid state components for an adjustable alarm delay circuit. The delay is field adjustable

from 1/2 to 6 seconds and is provided to minimize the possibility of fire alarms resulting from transient U/V radiation, such as lightning.

During normal operation the master fire alarm relay in the alarm module is unenergized and the master trouble relay is energized.

## SUPERVISORY MODULE

The supervisory module contains the balance of the electronic components required for fire detection including two sets of relays. Two fire detector heads can operate from one supervisory module. If only one head is required, its signal wiring can be connected to both inputs.

During normal system operation the U/V source in each detector head is energized twice each second from the solid state flasher circuit in the power module. This causes the test sources to emit flashes of U/V radiation which, in turn, cause the U/V detectors to conduct. These pulses are directed to the supervisory module and cause the associated transistors to conduct at the same rate. Conduction at this rate is sufficient to energize the trouble relay circuit but is not sufficient to cause fire relay circuit to become de-energized. Thus, during normal operation both pairs of relays are energized. In this condition the detector indicator lights associated with each supervisory module are lighted. Under normal conditions these relays keep the master fire alarm relay in the alarm module from being energized and the master trouble alarm relay energized.

Supervisory modules are available with sensitivity controls. Each detector

can be field adjusted to the desired fire detection level. The control reduces the sensitivity level of a detector to 35%.

## SYSTEM POWER

Input power for the system may be obtained from two separate sources. One powers the alarm, power and supervisory modules; the external fire alarm circuit; and auxiliary equipment. The other source powers the no confidence alarm circuit and the confidence alarm light.

Failure of the main power or associated components or wiring will result in a trouble alarm signal — the NO CONFIDENCE light on. Failure of the trouble alarm power causes the CONFIDENCE ALARM POWER indicator to go out and the master trouble relay to drop out and its contacts to close. These may be used in a trouble alarm circuit for an external audible device.

## OPTIONS

### Sensitivity Adjustment

Supervisory modules are available with sensitivity controls as an option. With this option each detector head can be field adjusted to increase the fire intensity required to obtain a fire signal.

### INSTALLATION

The screw type terminals in the control unit permit connection to the detector heads and to almost any type of external alarm devices such as audible signals, warning lights, automatic shut-down or fire extinguishing equipment. Two separately fused fire alarm and auxiliary circuits are provided.

Terminals are also provided for connecting test and reset switches remotely.

## TYPE 616

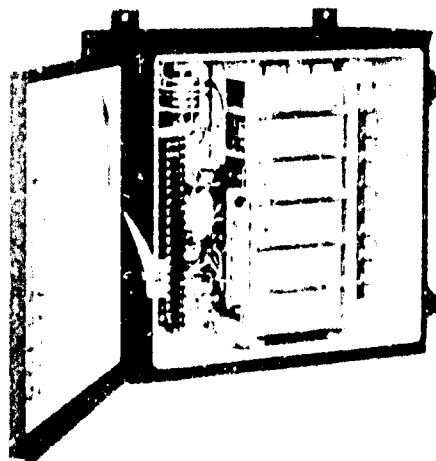


Fig 24 Detector controllers (McGraw-Edison Co. )



## HOW TO ORDER

Determine the number and type of detector heads — Model 564 or Model 567 — required to protect the area. Plan your installation using a sufficient num-

## FEATURES...

- Factory mutual approved
- Flame simulation for continuous self-checking
- Solar blind
- Fast response
- Fire, auxiliary and no-confidence circuits
- Extinguisher circuit for each head
- Adjustable time delay
- Voltage regulation
- Wide cone of vision
- Monitors up to eight detectors up to 1500 feet
- Adjustable sensitivity control
- Solid state components
- Rugged plug-in modules
- Easy to install and maintain
- Adjustable sensitivity for each head
- Indicator lights for each zone
- Extinguisher override by pass circuit

## SPECIFICATIONS

Service Ratings	NEMA 3, 12 Weatherproof and Dust Tight
Operating Voltage	See Table 2
Power Consumption	Approx. 90 VA (excluding loads)
Connected Load Ratings:	
Fire Alarm & Zone Circuit Combined	3 amp. inductive 5 amp. resistive @ 120 VAC
No Confidence Alarm	3 amp. inductive 5 amp. resistive @ 120 VAC
Alarm Delay	Adjustable from 1/2 to 6 seconds after flame detection
Ambient Temperature	-40° to 165°F (-40° to 74°C)
Weights:	
Installed:	75 lbs. max.
Shipping:	110 lbs. approx.

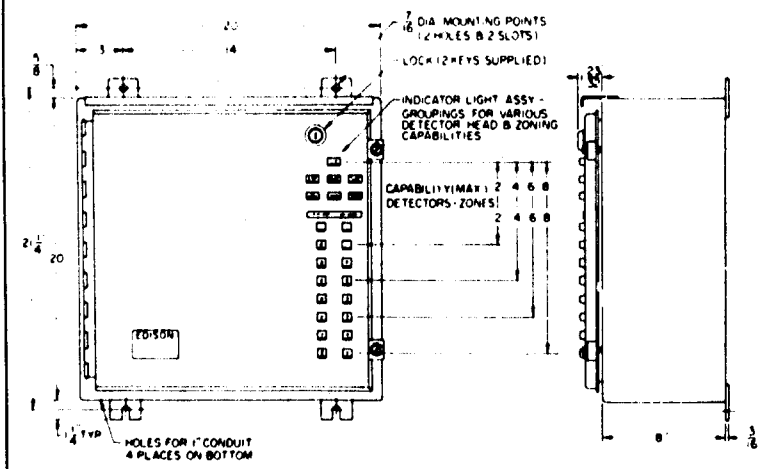


Fig 25 Detector controllers (McGraw-Edison Co.)

ber of heads so placed that no point will extend beyond the viewing field nor beyond the distance calculated for the flame source. Refer to Figure 1 on page 8.

Select options and the fire detection capability desired in order to determine the number and type of supervisory modules to be supplied with control unit. Model 616 control units are normally wired for 4 supervisory modules each of which will accommodate 2 fire detector heads.

Part number coding shown below completely identifies the Model 616 control unit.

616	—	0	5	1	8	1
						Manufacturer Series
						No. and Type of Supervisory Modules supplied (See Table III)
						Operating Voltage (See Table II)
						*Zoning Capabilities (See Table I)
						Options by Factory only.
						Model Number

Example of Part Numbering Code: 616-05181 a Model 616 control unit supplied with 5 zoning relays, operating power from 120 volts, 60 Hz. Fire Detection capability of 8 detector heads, four supervisory modules with sensitivity controls, unit built to manufacturer's series one design.

TABLE 1 Fire Detection Capability		
Extinguisher Zoning Capabilities	2nd Dash No.	
Zones		
1	Thru	8

All control units are factory wired for 8 zones. Zone indicator lights numbered one through eight will be supplied unless specified otherwise on order.

TABLE II	
Operating Voltage -Single Phase-	3rd Dash No.
120V (102-132V) 60 Hz.	1
220V (176-240V) 60 Hz.	2
115V (94-129V) 50 Hz.	5
127V (102-140V) 50 Hz.	6
220V (176-240V) 50 Hz.	8
240V (196-264V) 50 Hz.	9

TABLE III Fire Detection Capability Without Sensitivity Control		
Fire Detection Capability	Supervisory Modules Supplied	4th Dash No.
2	1	1
4	2	2
6	3	3
8	4	4
With Sensitivity Control		
2	1	5
4	2	6
6	3	7
8	4	8



**PYR-A-LARM®**  
Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

## Ultraviolet Controllers

Catalog  
Number  
**7150**

SERIES R-7300, R-7301, R-7302

Pyrotechnics  
**16p** | PROTECTIVE SYSTEMS

### INTRODUCTION

The Pyr-A-Larm Ultraviolet Controllers are for use with one or more (8 maximum) Flame Detectors, Series C-7037 or C-7050 to form a complete ultraviolet fire detection system. The controllers incorporate all electronic circuitry, relays, switches, and indicating components required for system operation.

The Series R-7300 is a surface mount unit for enclosure inside cabinets or cubicles while the Series R-7301 and R-7302 are slim rack-mount units that fit any standard 19" instrument rack arrangement.

The Series R-7301 and R-7302 Controllers are available with various options, including load monitoring relays, automatic ac/dc changeover, and manual optical integrity. The Series R-7302 Controller features automatic optical integrity and a digital display to indicate exact locations and types of system faults. All controllers can handle up to eight (8) detectors.

### TECHNICAL DESCRIPTION

The controller is of modular form and consists of continuously supervised electronic circuitry for processing a detector signal, controls for adjusting sensitivity and time delay, by-pass switches, and visual indicators to indicate condition and response capability of the system.

The unit contains three independent relays. The first relay (instantaneous or alarm relay) is energized immediately when the UV radiation received by a detector exceeds a pre-set level. The second relay (time delayed or extinguisher relay) is energized when a detector signal is present for a pre-set time. This time interval is field adjustable over a range of .2 seconds to 12 seconds. The third relay (trouble relay) is normally energized and monitors the system for electrical faults (power failure, open or shorted detector leads, circuit board removal, etc.) that could prevent proper operation.

The controller's sensitivity is field adjustable for 10, 25 or 100 counts per second response. This means that the UV radiation generated by a gasoline fire with one square foot surface area, can be detected at distances ranging from about 15 feet to greater than 45 feet. Where maximum sensitivity can be utilized, the 10 cps (counts per second) sensitivity setting may

be used. However, where ambient radiation presents an application problem, less sensitive settings (25 or 100 cps) may be required.

Note: The term "counts per second" is used to designate the number of voltage pulses generated per second by the UV detector tube. This discharge rate is dependent upon the intensity of UV radiation reaching the detector, which is a function of flame size, flame temperature, and distance from the detector. The closer a fire is to the detector, the smaller the flame that is needed to actuate the system. Programming the controller to respond to a low discharge rate (10 cps) results in high system sensitivity. Conversely, programming to a high rate (100 cps) results in low sensitivity.

Operating temperature range is from -5° F to +170° F (-21° C to +77° C).

### OPTICAL INTEGRITY (OPTIONAL)

Optical integrity, further described in Catalog Number 6141, makes certain that the ultraviolet sensing optical surfaces are clean and that all sensing, optical, and alarm circuits are operational. Optical integrity is offered as a manual option for Series R-7300 and R-7301 Controllers.

**Automatic optical integrity**, with digital display providing continuous monitoring of all elements of the system is supplied with Series R-7302 Controllers. With this outstanding feature, continuous tests are performed automatically without actuation of the output relays. The digital display specifically identifies, by numerical coding, any number of fault conditions that may develop in the UV detector or in the controller itself, or any interconnecting wires. Should a fault occur, a monitoring relay with remote indication capability registers that fact, and simultaneously the exact nature of the fault is shown on the digital display. If the fault involves a reduction in the sensitivity of any detector for any reason, the display will also identify which detector or detectors are involved.

This testing procedure can also be performed manually at the R-7302 Controller.



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

February, 1977

NEW ISSUE

Fig 26 Detector controllers

Pyrotechnics  
**16p** | PROTECTIVE SYSTEMS



# Honeywell

## Single Zone Fire Alarm Panels

MODEL NUMBER W939

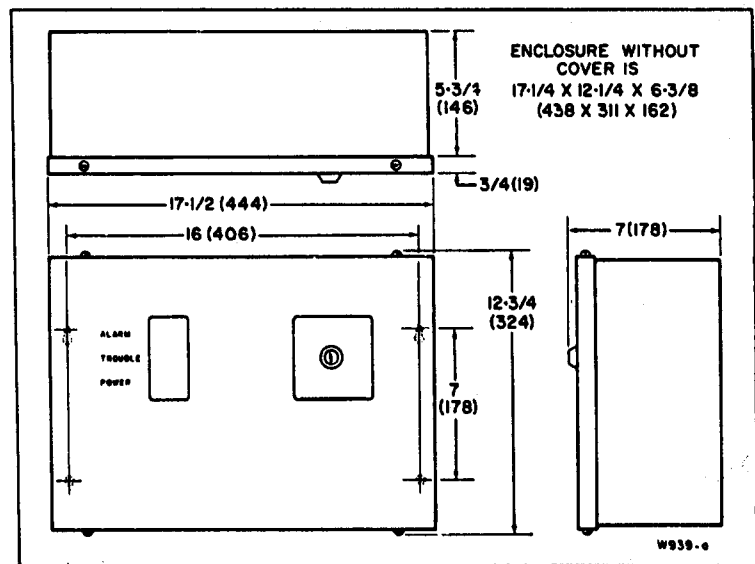
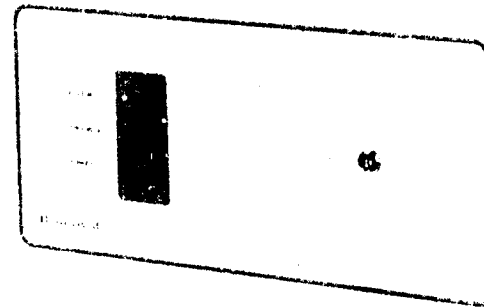
### General

The W939A Smoke Detector Power Supply, used in conjunction with TC100A Ionization Smoke Detectors, automatic fire detectors, and manual stations, can be used independently for releasing smoke dampers or smoke barrier doors, and it can operate shut down equipment and exhaust fans. It can also be employed in existing fire alarm systems when connected to a suitable UL listed control unit.

The W939B Fire Alarm Control Unit is used with ionization or photoelectric smoke detectors, automatic fire detectors, manual stations, and signaling devices to provide a complete fire protection system. This solid state, low voltage panel provides power for ionization smoke detectors on the initiating device circuit. It also contains the necessary switching to monitor trouble and alarm conditions.

The W939B provides ground fault detection, visual annunciation, remote test and reset, and municipal connection with disconnect for testing. Optional four-wire (Class A) operation of the initiating device circuit and operation from standby rechargeable batteries with an automatic battery charger is available. This panel includes two supervised signaling circuits, a supplementary power output for photoelectric smoke detectors, and a local audible. Signals may be coded or non-coded, using vibrating or single stroke signals.

The W939 panels are designed for surface or semi-flush mounting and they are listed by UL and ULC and FM approved.



W939A, 8 DIMENSIONS IN INCHES (MILLIMETERS)

Fig 27 Zone panels



# Pyr-A-Larm®

Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

## Fire Indicating Unit

MODEL FIU-6

Pyrotechnics  
16p  
PROTECTIVE SYSTEMS



The Pyr-A-Larm Fire Indicating Unit, Model FIU-6, is a control-power unit for the Pyr-A-Larm automatic fire detection system. The FIU-6 is intended to be used in multiple zone systems utilizing Zone Indicating Units, Zone Code Panels, Supplementary Relay Panels, Emergency Power Units, and Remote Annunciators. It offers these advantages in automatic fire alarm systems.

**FULLY APPROVED SYSTEM:** The FIU-6 is listed by Underwriters' Laboratories, Inc., and Underwriters' Laboratories of Canada as a local and auxiliary system for automatic and manual fire alarm use. It is also approved by FM. The unit can be directly connected to remote annunciators, central stations and to fire departments via appropriate equipment. It can also be used to shut down ventilation fans, and automatically actuate smoke dampers extinguishing equipment.

**MULTI-ZONE APPLICATION:** Although the FIU-6 is available in its own enclosure, it is usually provided with other multi-zone equipment, mounted in a common enclosure. Specific information on common enclosures is given in Architect Specification Sheet No. 420-1. When ordered as part of a multi-zone system, the FIU-6 is housed in a common enclosure and is furnished with all interconnecting wiring between associated Pyr-A-Larm panels. This reduces installation time and possible errors.

**SYSTEM CAPACITY:** The FIU-6 can operate up to eight (8) Model ZIU-6 Zone Indicating Units, each unit having a four zone capability, making a total system capacity of 32 zones, and up to 80 lamps for either zone or remote annunciation. Any number of ionization detectors (ceiling mounted or air duct type), manual stations, thermal detectors and up to five (5) flame or photoelectric detectors may be intermixed on the supervised detector circuit of each zone. However, good fire protection system design dictates a practical limitation to the number of detectors used on one zone. All detectors, mounted in Pyr-A-Larm bases, have the exclusive Pyr-A-Larm flashing alarm indicator to identify the detector initiating the alarm, as well as being interchangeable.

**AUDIBLE ALARM DEVICES:** Up to forty (40) Pyr-A-Larm polarized bells or twenty (20) polarized horns may be connected to the exclusive Pyr-A-Larm Supervised Alarm Circuit. This circuit employs no voltage compensating resistors. Hence, the number of alarm devices may, at any future date,

be increased or decreased without changing the types of devices or making resistor adjustments. The last alarm device, used at the end of the supervised circuit, incorporates a built-in 12K ohm resistor.

**COMPLETE SUPERVISION:** All relay coils are supervised. The detector circuit is supervised to detect open or short circuits, or loss of power or undervoltage. The alarm circuit is supervised to detect open or short circuits, and ground faults. Automatic emergency power is available as optional equipment.

**HIGHEST POSSIBLE RELIABILITY:** All components are the latest in high reliability, such as glass-sealed reed relays and control relays which are enclosed in heat and shock resistant dust covers. The unit is designed and tested to operate over a temperature range of -40°F to +160°F. An audible and visual trouble indicator is built into the unit and both input supply lines are fused.

**SAFER TO OPERATE:** Fire alarm signals override trouble indications to avoid misinterpretation and confusion. Both trouble and alarm silence switches have ring-back circuits so they cannot be inadvertently left in silence position. The unit has a disconnect switch which, in the disconnect position, isolates the external circuit and devices that are connected to terminals 4, 5 and 6 (alarm actuated). The trouble lamp will remain lit while the disconnect switch is in the disconnect position.

**FLEXIBLE MECHANICAL DESIGN:** The FIU-6 is usually mounted in a common enclosure; however an enclosure to mount only the FIU-6 is available with a surface or semi-flush mounting feature. When the FIU-6 is installed, the enclosure or cabinet is mounted first. Wiring is then brought into the cabinet, after which the FIU-6 chassis is installed. Eight (8) electrical knockouts are provided and ample room is available for running wire to terminals. All connections are made to heavy-duty screw type terminals; no soldering is required. The enclosure is made of sheet steel finished with red, baked, textured enamel. All visual indicators are visible without opening the key-locked door. The door is attached with a piano-type hinge.



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

July, 1972

Supersedes sheet dated 8/70

Fig 28 Zone panels

Pyrotechnics  
16p  
PROTECTIVE SYSTEMS



# Pyr-A-Larm®

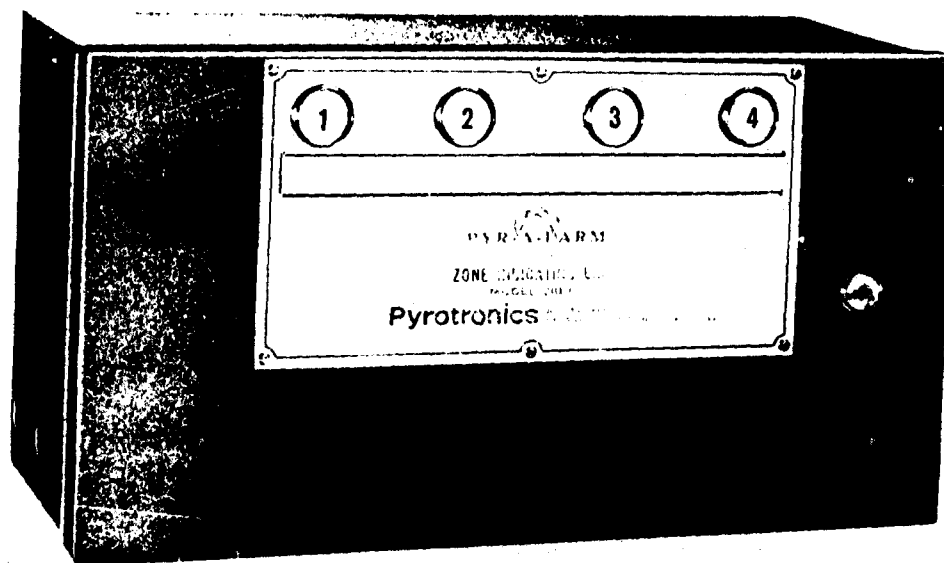
Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

## Zone Indicating Unit

MODEL ZIU-6

Pyrotechnics 16p | PROTECTIVE SYSTEMS



MODEL ZIU-6

### INTRODUCTION

The PYR-A-LARM Zone Indicating Unit, Model ZIU-6, is a multiple zone indicating unit, designed for use in large fire detection systems. It subdivides alarm and trouble signals from large areas so that location of fire or trouble may be identified more readily. In addition, the Zone Indicating Unit provides separate control of supplementary equipment in each zone. The Model ZIU-6 offers new features and important advances for automatic fire alarm systems. The features of this equipment are as follows:

**System Capacity:** Each ZIU-6 provides four-zone indication. Up to eight Zone Indicating Units may be used with one Model FIU-6 Control Panel, to provide a total system capability of 32 zones. Any number of ionization detectors, manual stations, thermal detectors and up to five (5) flame or photo-electric detectors may be intermixed on the two wire supervised detector circuit of each zone. (Good fire protection system design dictates a practical limitation to the number of detectors used on one zone). All detectors mounted in Pyr-A-Larm bases have the exclusive Pyr-A-Larm flashing alarm indicator to identify the detector initiating the alarm.

**Supplementary Annunciation and Control:** A remote annunciator can be used with the FIU-6 and ZIU-6 control equipment to duplicate, at a remote location, the "Fire," "Trouble," "Power" and "Zone" indications.

Each zone provides a set of single pole-double-throw relay contacts (alarm operated) that are available for controlling equipment such as fire doors, extinguishing systems, fans and blowers, etc. These contacts are rated at 115 volts, 60 Hz, 2 amps resistive. In addition, on special order, a set of normally closed relay contacts (trouble operated) can be provided for each zone, in place of the remote annunciator capability.

**Fully Approved System:** When the Model ZIU-6 is used in conjunction with the Model FIU-6 Fire Indicating Unit, it is listed by Underwriters' Laboratories, Inc. and Factory Mutual as an auxiliary and local system for automatic and manual fire alarm use. The ZIU-6 functions to localize and indicate the area where a fire or trouble condition has been detected. The ZIU-6 is approved to automatically activate extinguishing systems, release smoke barrier doors, shut down ventilating fans, etc. on a zone basis.

**High Reliability:** Fire Alarm Signals override trouble indications to avoid misinterpretation and confusion. When the fire is extinguished and the system is reset, any existing trouble indications will reappear. Optional disconnect switches on a zone basis are available for isolating the zone controlled circuits, to permit testing, fire drills or repair work, without affecting supplementary equipment. All relay coils are supervised to detect open circuits or loss of power. All relays are enclosed in a metallic cover to protect the contacts from mechanical abuse and dust. The unit is designed and tested to operate over a temperature range of -40°F to +160°F.

**Flexible Mechanical Design:** The ZIU-6 is available in surface or semi-flush mounting. All visual indicators are visible without having to open the key-locked door. The cabinet is made of sheet steel finished with red, baked, textured enamel. The door is attached with a piano-type hinge.

**Easy Installation:** The cabinet housing is mounted first. Wiring is next brought into the cabinet, after which the ZIU-6 chassis is installed. Eight (8) electrical conduit knockouts are provided in the cabinet, and ample room is provided for running wire to terminals. All connections are made to heavy-duty screw type terminals, no soldering required.



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

February, 1973

Supersedes sheet dated 3/72

Fig 29 Zone panels

Pyrotechnics 16p | PROTECTIVE SYSTEMS



# Pyr-A-Larm®

Early Warning Fire Detection and Alarm Systems

Engineer and Architect Specifications

## Supplementary Relay Panel

MODELS SRP-410A & SRP-810A

Pyrotronics 16p PROTECTIVE SYSTEMS



SUPPLEMENTARY  
RELAY PANEL

### INTRODUCTION

The Pyr-A-Larm Models SRP-410A and SRP-810A are fire-alarm operated Supplementary Relay Panels designed for use with Pyr-A-Larm Control Panels. These relay panels permit the control of supplementary electrical equipment (having current requirements up to 10 amperes), such as ventilation system fans, motors, etc. Both panels are Underwriters Laboratories, Inc., listed for use in either a Pyr-A-Larm High Voltage common enclosure or their own enclosure.

The Model SRP-410A contains four independent relay circuits while the Model SRP-810A contains eight relay circuits. Each relay circuit contains two independent sets of normally open and normally closed contacts. The panels have the following features:

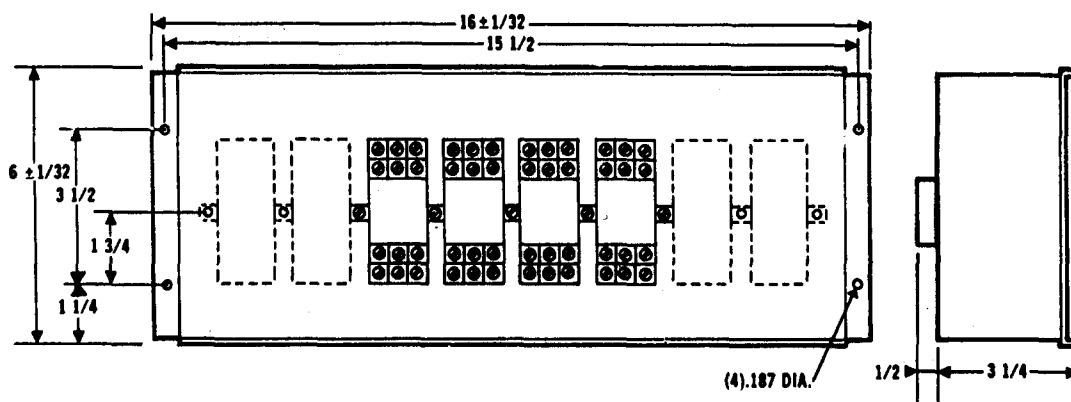
- **Two Modes of Operation** — The relay panel may be connected with relays either normally energized or normally de-energized. The choice of the operating mode is dependent upon the equipment to be controlled and the particular application.

When the relays are connected for normally energized operation, the relay or relays will operate (de-energize) in response to an alarm signal from the Pyr-A-Larm Control Panel, and thereby control the supplementary electrical equipment by means of its normally open or normally closed contacts. When the relays are connected for normally de-energized operation, the relay or relays will operate (energize) in response to an alarm signal from the control panel.

Note: If the normally energized mode is chosen to operate with an Emergency Power Supply, contact our Applications Engineering Department for special instructions.

- **Flexibility of Operation** — By means of convenient terminal blocks, the relays may be connected to operate individually in response to alarm signals associated with specific zones or interconnected to operate simultaneously in response to a specific alarm signal. This makes the relay panels adaptable to each specific application.

### MOUNTING DATA



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A Baker Industries Company

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Supersedes Sheet dated 7/72

Fig 30 Relay panels

Pyrotronics 16p PROTECTIVE SYSTEMS



**PYR-A-LARM®**  
Early Warning Fire Detection and Alarm Systems

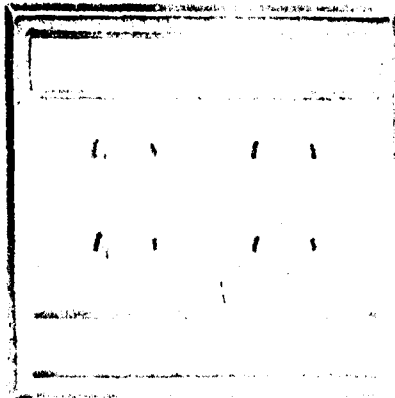
## Remote Lamp Panels

Catalog  
Number  
**8012**

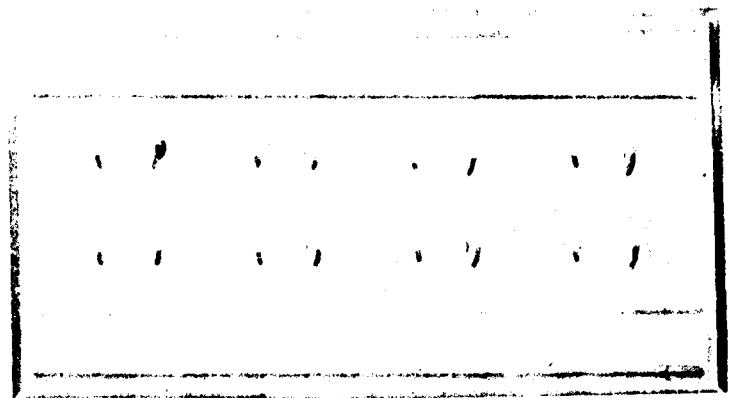
Engineer and Architect Specifications

MODELS RLP-4, RLP-8 & RLP-12

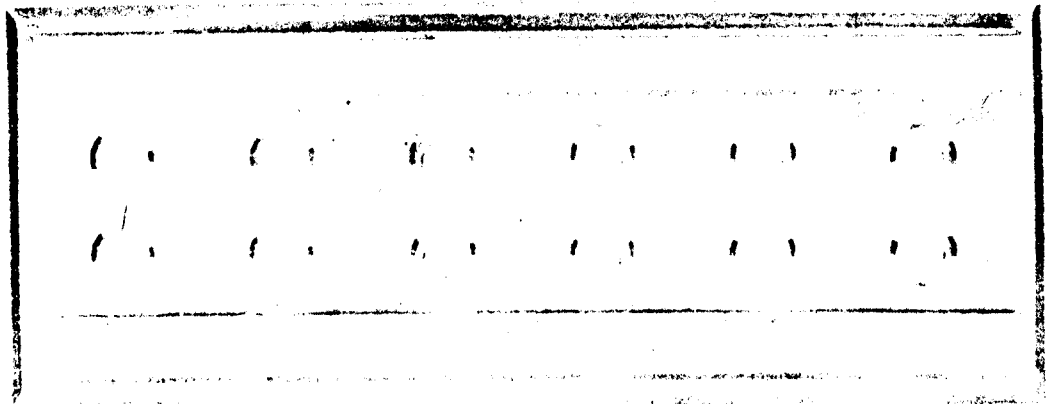
Pyrotronics **16p** PROTECTIVE SYSTEMS



MODEL RLP-4



MODEL RLP-8



MODEL RLP-12

### INTRODUCTION

The Pyr-A-Larm Remote Lamp Panels, RLP-4, RLP-8, and RLP-12 are designed for use with all Pyr-A-Larm systems where remote lamp annunciation of the detection system activity is desired. This activity could be DI-2 type detector operation using 24V lamp directly or using dry contacts, one may indicate zone alarm, system alarm, trouble, power failure, etc.

The RLP Panels are normally fitted with neon lamps to duplicate the high voltage detector pulse lamp operation. However, 6-volt, 12-volt, 24-volt, 48-volt and 120-volt lamps are

available as optional items to match the electrical characteristics of any desired system.

The RLP-4 Remote Lamp Panel is equipped with 4 lamps beneath clear lenses and is designed for 2-gang switch box mounting. The RLP-8 has 8 lamps and requires 4-gang switch box mounting, while the RLP-12 has 12 lamps and requires 6-gang switch box mounting. The panels are equally attractive whether mounted vertically or horizontally.

Each panel has an upper and lower bracket to accommodate plastic nameplate strip for lamp identification.



**Pyrotronics**

A Baker Industries Company

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Supersedes sheet dated 3/72

Fig 31 Annunciator panels



# Pyr-A-Larm

Early Warning Fire Detection and Alarm Systems

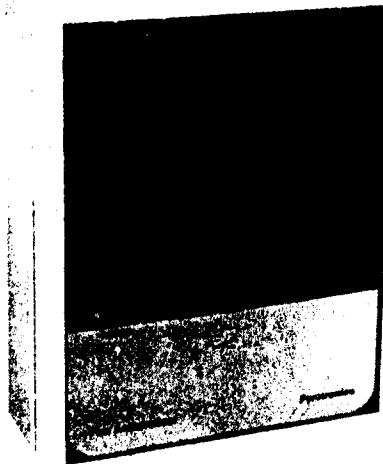
Engineer and Architect Specifications

## Remote Fire Annunciators

MODELS RA-1, 12, 24, 36, & 48

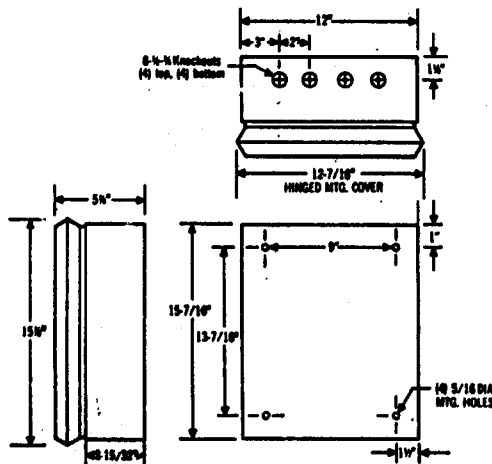
Catalog  
Number  
**7301**

Pyrotronics 16p PROTECTIVE SYSTEMS



MODELS RA-1, 12, 24, 36, & 48

### MOUNTING DATA



### INTRODUCTION

The Pyr-A-Larm Model RA-1 Annunciator which is Underwriters' Laboratories, Inc. listed, is intended to be used with low voltage control panels, such as the CP-2, CP-70, CP-150, and CP-250. This Annunciator provides a remote indication of system alarm, trouble, and power loss. Visual indicators labeled "Fire" and "Trouble" with internal buzzers call attention to signals received from the control unit. In addition there is provision for the connection of a local non-supervised 120 Vac alarm bells(s) as required. A momentary operated "Silence" switch, when depressed, will silence the internal alarm and trouble buzzers as well as any externally connected alarm bells(s). Local 120 Vac power must be provided at the Annunciator panel which is used exclusively for activating the Annunciator's "system" alarm and trouble indicating devices.

The Pyr-A-Larm Models RA-12, 24, 36, and 48 are attained by adding up to four lamp circuit modules to the RA-1. Each module consists of 12 lamp circuits which require a nominal 22 volts dc provided by the low voltage control unit which is switched by remote annunciator zone terminal 2. A lamp circuit, when activated, for "Fire," back-lights its corresponding zone number on the Annunciator's translucent front panel. Dual lamps are provided for each zone number to assure positive identification in the event of lamp failure.

A maximum of three RA-1, 12, 24, 36, or 48 Annunciators per system is permissible except when the CP-70 is used. In this application only one Annunciator is permissible.



**Pyrotronics**

A Baker Industries Company

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March, 1976

Supersedes Sheet dated 2/74

Fig 32 Annunciator panels

Pyrotronics 16p PROTECTIVE SYSTEMS



**Pyr-A-Larm®**

# System 3

Universal Alarm Control

## Battery Module

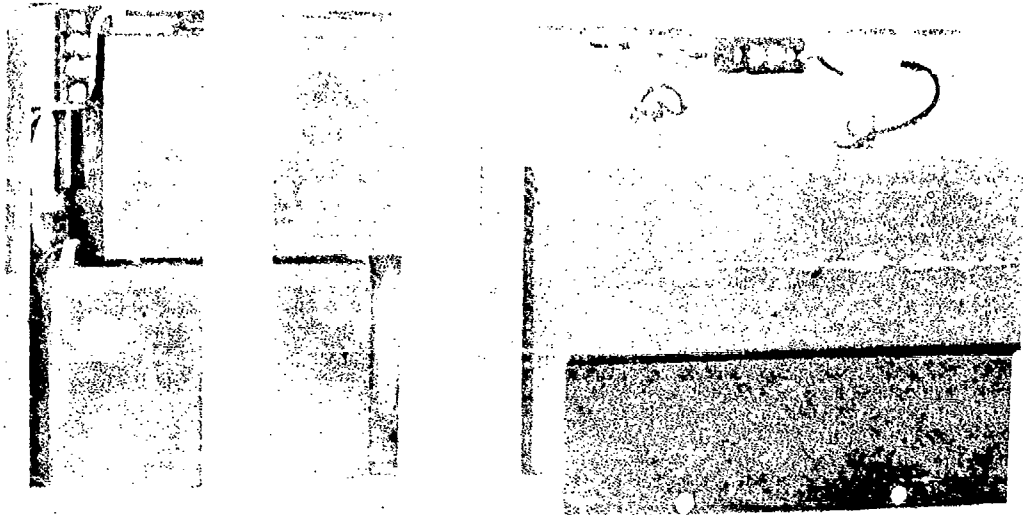
(STANDBY POWER SUPPLY)

MODELS BM-30, BM-31

CATALOG  
NUMBER

3351

### Engineer and Architect Specifications



#### Features

- UL Listed
- Sealed Spillproof Rechargeable Lead-Acid
- High Energy Density
- No Corrosive Fumes
- Mounts Within System Enclosure
- Long Life Cycle

#### Description

The Pyr-A-Larm Battery Supply Module, Models BM-30 and BM-31 provide 24 volt emergency standby power to operate System 3 Universal Alarm Control during failure of the normal commercial power source. The Model BM-30 contains two sealed lead-acid rechargeable batteries (12 volt each) that provide 4.5 ampere hours of energy. The Model BM-31 contains two lead-acid rechargeable batteries (12 volts each) that provide 9 ampere hours of energy.

The lead-acid batteries are of the gelled electrolyte type which are especially suited to high discharge currents. They are also ideally suited for long term standby power when used with the proper charging circuits. Both models contain support bracketing for mounting within System 3 standard enclosures. Terminals are provided for connecting both the BM-30 and BM-31 to Battery Charger Model BC-30 and the Meter Module Model MM-30.

The BM-30 occupies three standard module positions and is usually installed immediately adjacent to the last system module in the enclosure. The BM-31 occupies four standard module positions and must occupy the center four module positions in either the 2nd, 3rd, 4th, or 5th module rows of the enclosure.

The Models BM-30 and BM-31 are Underwriters Laboratories Inc. listed.



**Pyrotronics**

A Babel Industries Company  
8 Ridgedale Avenue  
Cedar Knolls, New Jersey 07927

Fig 33 Battery packs



**PYR-A-LARM<sup>®</sup>**  
EARLY WARNING FIRE DETECTION AND ALARM SYSTEMS

Engineer and Architect Specifications

# Emergency Power Supply

MODEL 458

Pyrotechnics 16p PROTECTIVE SYSTEMS

## INTRODUCTION

The Pyr-A-Larm model 458 Emergency Power Supply provides emergency power for operation of the Pyr-A-Larm Fire Detection System in event of public utility power failure. This unit is listed by Underwriters Laboratories, Inc. for use with Pyr-A-Larm control equipment. The unit is also approved by Factory Mutual and the Canadian Standards Association.

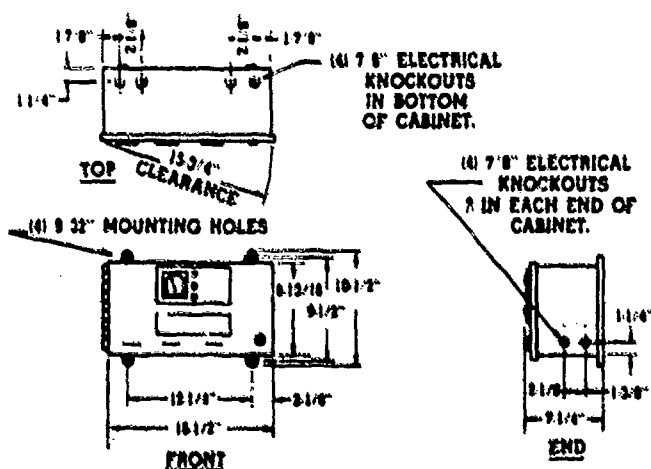
The Emergency Power Supply consists of: 1) a battery charging unit which automatically maintains the batteries at peak voltage and 2) an inverter to change the 12 volt DC battery power to 120 volt, 60 Hz power for operation of the fire detection system. The unit shall be used in conjunction with 24, 36 or 48 hour batteries, depending on the desired length of emergency power supply protection.

The operation of the Emergency Power Supply is completely automatic. If a public utility power failure occurs, the unit automatically switches to battery operation and activates visual and audible alarms. The audible alarm may be silenced by push button. When utility power is restored, the unit will automatically return to standby operation and recharge batteries.

The Emergency Power Supply can provide power up to 75 Volt Amperes. This is sufficient to power a system composed of a Fire Indicating Unit (Model FIU-6), up to eight Zone Indicating Units (Model ZIU-6), and up to five (5) Model BAC Bells, or two (2) Model HAC Horns. When fewer Zone Indicating Units are used, the number of audible devices may be increased. For example, ten (10) bells or four (4) horns may be used when no ZIU-6 units are used.

## ARCHITECT'S SPECIFICATIONS

The Emergency Power Supply for the fire detection system shall be a Pyr-A-Larm Model 458, or equivalent. In event of public utility power failure the unit shall automatically provide emergency power to fire detection system for a period up to approximately \_\_\_\_\_ hours (insert hours depending on battery capacity used). In addition, the unit shall provide visual and audible alarms of public utility power failure. It shall have normally open and normally closed contacts for control of supplementary equipment. When utility power is restored, unit shall automatically return to standby operation.



**Pyrotechnics**

A Baker Industries Company

8 Ridgedale Avenue, Cedar Knolls, New Jersey 07927

April, 1973

Supersedes Sheet dated 7/70

Fig 34 Emergency power units



APPENDIX C

FIRE EXTINGUISHING SYSTEMS AND EQUIPMENT

REPRESENTATIVE SYSTEMS AND EQUIPMENT



A total flooding Carbon Dioxide System protects the vital records in this vault.

# Carbon Dioxide Systems

## DEFINITION

Carbon dioxide is a clean, non-corrosive, non-flammable gas which extinguishes fire by diluting flammable mixtures of air and gas or vapor to proportions below their flammable or explosive limits. It is especially valuable where other extinguishing mediums might damage stock or equipment.

## TYPES OF GAS STORAGE

Grinnell installs carbon dioxide systems with either of two forms of storage for the fire extinguishing gas: in high pressure non-refrigerated storage cylinders or in low-pressure refrigerated pressure vessels. It is stored as a liquid and expands at a ratio which produces 450 cubic feet of fire-smothering gas for each cubic foot of liquid storage.

## DESIGN OF CARBON DIOXIDE SYSTEM

Because of its expansive force, carbon dioxide penetrates every nook and corner of the enclosed space into which it is discharged, seeking out every place where a flammable mixture might exist. Carbon dioxide systems are so designed and the piping so proportioned as to prevent freezing due to expansion in the pressure vessel, valves, piping or discharge nozzles. Since carbon dioxide does not deteriorate in storage, the effectiveness of the gas is just as great the day the system is needed as it was the day the pressure vessel was filled. Scheduled checking of cylinder weight or reading of gage on the low-pressure storage

is all that is required to be sure of an available carbon dioxide supply when needed.

Two or more spaces may be protected with a single storage supply through the use of selector valves. In such installations, the required storage capacity is determined by the largest hazard to be protected.

## SYSTEM'S CAPACITY

The three standard methods of application are known as Total Flooding, Local Application and Delayed or Prolonged Discharge.

Total Flooding application is flooding the entire space with carbon dioxide and is generally used when protecting enclosed or semi-enclosed spaces.

## METHODS OF APPLICATION

Local Application is applying carbon dioxide directly on one or more hazards where total flooding of the entire space is impractical.

The Delayed or Prolonged Discharge type system discharges at an initially high rate followed by an extended discharge at a lower rate for either total flooding or local application. This method is used for the protection of enclosed or semi-enclosed rotating electric equipment and other types of deep-seated smoldering fires that may reignite after the flame has been extinguished.

Fig 35 Carbon dioxide systems (Grinnell Corp.)





High-pressure carbon dioxide supply storage for total flooding system.



# Carbon Dioxide Systems

## Auxiliary Equipment

Alarms, indicating lamps and annunciators may be automatically operated by a pneumatic switch (circuit closer) whenever carbon dioxide is discharged from the cylinder bank into the system's manifold by automatic detector operation. A pneumatic switch may also be used to stop motors of conveyors, mixers, blowers, ventilation systems and electric heaters for rooms, ovens, kettles, etc. Both high-pressure and low-pressure systems are equipped with means for manual release if fire is detected before automatic detectors or thermostats actuate the system.

Blowers and motors of forced ventilation systems should be stopped to confine the carbon dioxide gas when system operates.

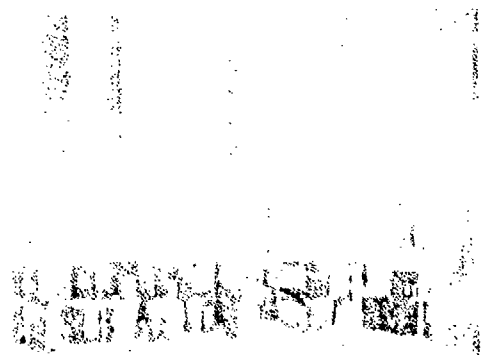
Conveyors, mixers and moving equipment should be stopped to prevent fire from spreading outside the protected area or space.

Doors, windows, dampers of forced ventilation ducts or openings, and shut-off valves in the piping to gas or liquid fired burners or heaters may be closed with a pneumatic release (pressure trip) which is operated by the pressure of discharging gas from the carbon dioxide systems.

Small size openings that cannot be fitted with dampers may be screened with carbon dioxide gas by use of special nozzles.



Volatile paint solvents with wide explosive-mixture limits in this paint mixing room are protected by total flooding with carbon dioxide. This automatically-operated system gives quick extinguishment of violent fire.



Carbon Dioxide System protects tube reducing machine operated with flammable hydraulic fluid.



Fig 36 Carbon dioxide systems (Grinnell Corp.)



# Fenwal Custom Engineered High Speed *Halon Fire Suppression Systems*

REACT FAST / LEAVE NO MESS / REQUIRE MINIMAL PIPING

A Fenwal Fire Suppression System using Halon 1301 is custom engineered to do one thing — PUT FIRES OUT FAST — when called upon.

Fenwal Fire Suppression Specialists survey every plant prior to installation and recommend the system dictated by the plant design. Once installed, these systems require only minimal maintenance and following a suppression, replacement of basic components is simple and fast.

The ultra high speed with which a Fenwal fire suppression system reacts is unchallenged in the industry. This capability did not come about by accident but rather it has resulted from our unique capability of suppressing explosions. Many of the high speed components used in these systems are

used or are modified for use in our fire suppression systems.

A Fenwal Fire Suppression System is a basically simple, yet extremely effective system. It contains a selected combination of Detectors, Agent Storage Containers, Alarms and Control Units. A typical system is shown in **Figure 1**.

Halon 1301 is used as the extinguishant. It is an odorless, colorless, electrically non-conductive gas that has been proven as an effective medium for extinguishing surface fires such as flammable liquids and on most solid combustible materials. With the use of specially designed Agent Storage Containers and custom designed nozzle arrangements, Fenwal **HALON 1301** systems require little or no piping.

FIG. 1 — TYPICAL HALON 1301 FIRE SUPPRESSION SYSTEMS

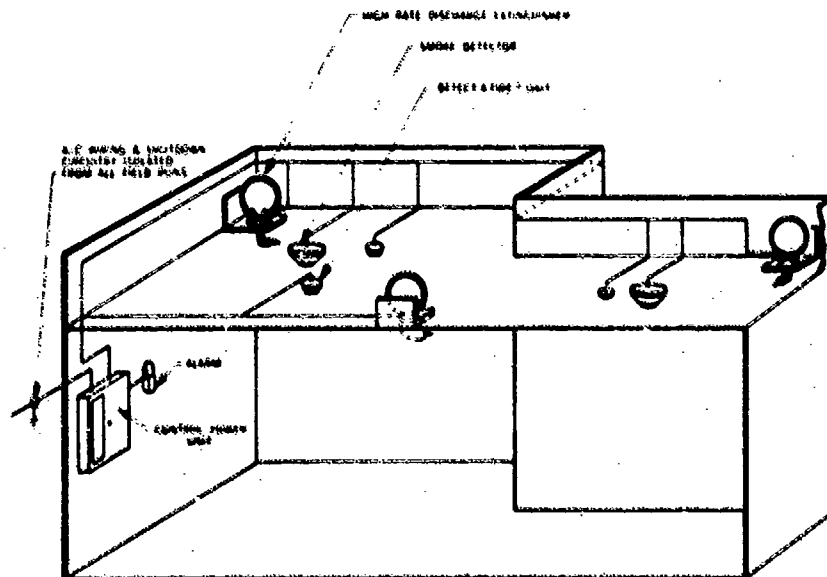


Fig 37 Halon systems (Fenwal Incorporated)



## Typical Fenwal High Speed Fire Suppression Systems.



Computer room showing Fenwal thermal detectors and products of combustion detectors mounted on ceiling area



Computer room showing Fenwal Fire Suppression Control Panels mounted on wall. Contains batteries for reserve power supply, detection, alarm, equipment shut-down, and extinguishing agent release capability for total computer room fire protection

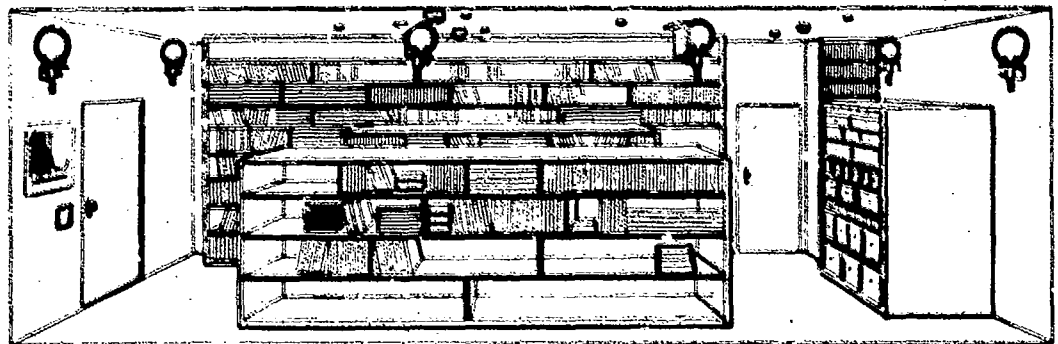
### COMPUTER ROOM AND UNDER-FLOOR AREA

In this computer room installation both the room and the under-floor area require fire protection. The room houses the expensive electronic data processing equipment. The under-floor area presents a hazard because of the wiring that passes through this area.

To protect this facility Fenwal DETECT-A-FIRE units are mounted overhead in the room and under-floor area to sense overtemperature and actuate the system. Agent storage containers are mounted above the ceiling of the room area and on the floor of the under-floor area, and when activated will discharge Halon 1301 through special spray nozzles. Total flooding is achieved in less than 10 seconds.

The two systems can be designed to operate independently or simultaneously and have provisions for manual actuation, audible alarm, remote alarm and or equipment shutdown. A trouble indicator horn is provided in the control panel.

Fenwal **Modular Systems** permit agent storage containers to be located within or immediately adjacent to the area being protected. Long and costly piping runs, common to central storage systems, are eliminated. An additional benefit to the user is the ease with which a modular system can be moved or expanded. Agent storage containers are mounted, electrical wiring is installed and expansion of an existing system is complete. Relocation of an entire system is virtually as simple.



### SECURITIES VAULT

To protect valuable property in this large 25' x 85' security vault area, six Halon 1301 storage containers are located at vital positions in the ceiling area. Fenwal DETECT-A-FIRE units and Products of Combustion Detectors are mounted at selected locations in the ceiling. The Products of Combustion

Detectors sense smoke and actuate an alarm only. The DETECT-A-FIRE Units are set to respond at 140 F and actuate the entire extinguishing system. Total flooding is achieved in less than 10 seconds. No floor space required for the protection system.

Fig 38 Halon systems (Fenwal Incorporated)



## INTRODUCTION

FiQuench Pre-Engineered Total Flooding Halon 1301 Fire Suppression Systems combine highly effective detection devices with new specially developed Halon 1301 containers for high speed agent discharge. FiQuench systems will provide fast, effective, and reliable service for many years when properly installed and maintained.

Total Flooding FiQuench systems are designed to provide fire protection within rooms, vaults, ovens, containers, enclosed machines, etc., wherever fixed enclosures are used. An inert atmosphere is created within the enclosure and then maintained for the required period of time, ensuring effective extinguishment of the fire in the specific combustible materials involved. This system has proven to be suitable for use on Class A, B, & C fires.

The system can be electrically actuated by automatic or manual means and has a discharge time of less than ten seconds. The Halon 1301 containers may be strategically located throughout the area to be protected. The high speed suppression of fire provided by FiQuench reduces property damage and holds thermal products of decomposition to the lowest possible level.

FiQuench containers unlike many others, does not require superpressurization. The Halon 1301 is contained at its own vapor pressure thus eliminating the complicated problems of field recharging and maintenance. All FiQuench system components are modular and do not require any special tools or equipment for installation.

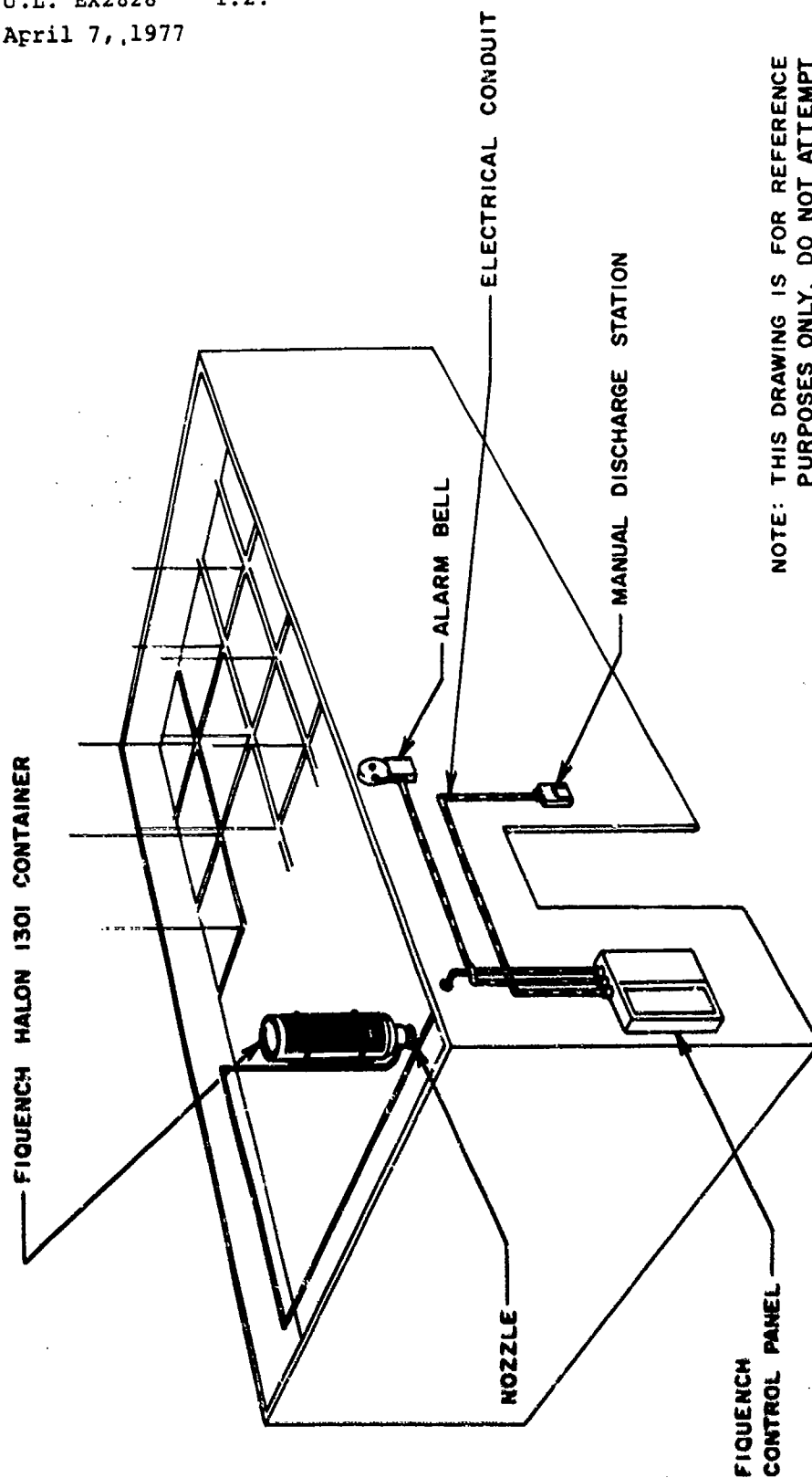
All FiQuench components manufactured by Fike Metal Products Corporation are U.L. listed unless otherwise noted within this manual. Any components incorporated into a FiQuench System that is manufactured by others, must be U.L. listed in order to have a U.L. Approved System. Underwriters Laboratories requires that all system wiring must, as a minimum, meet the National Electrical Code.

For exact details concerning your equipment including a detailed description, operation, and installation instructions refer to the preceding index to find the proper section and page number. The following illustrations should help give you a basic concept of what your FiQuench Pre-Engineered Total Flooding Fire Suppression System will look like.

Fig 39 Halon systems (Fike Metal Products Corp.)



U.L. EX2828 I.2.  
April 7, 1977



NOTE: THIS DRAWING IS FOR REFERENCE  
PURPOSES ONLY. DO NOT ATTEMPT  
TO INSTALL YOUR SYSTEM IN ACCOR-  
DANCE WITH THIS DRAWING.

Fig 40 Halon systems (Fike Metal Products Corp.)



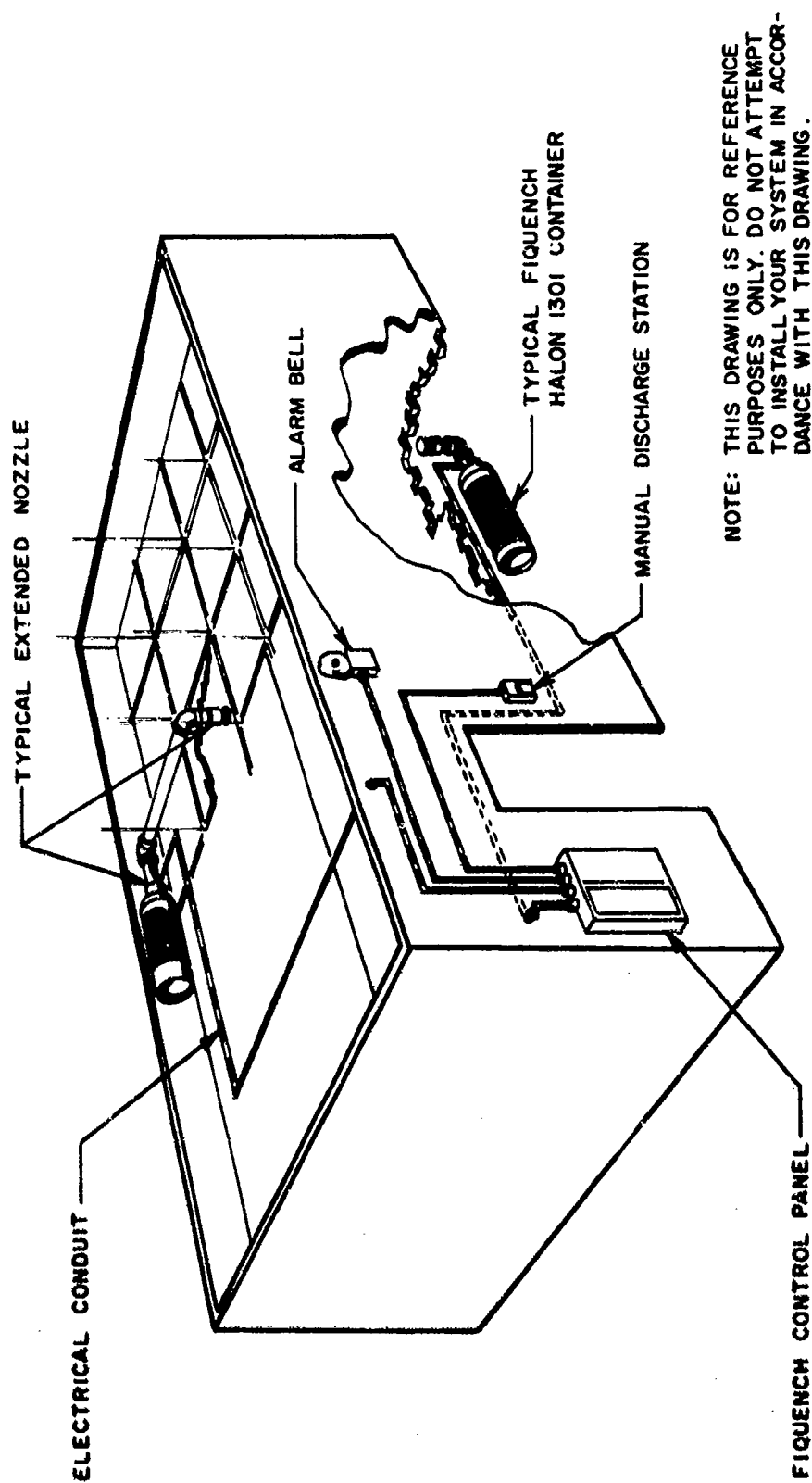
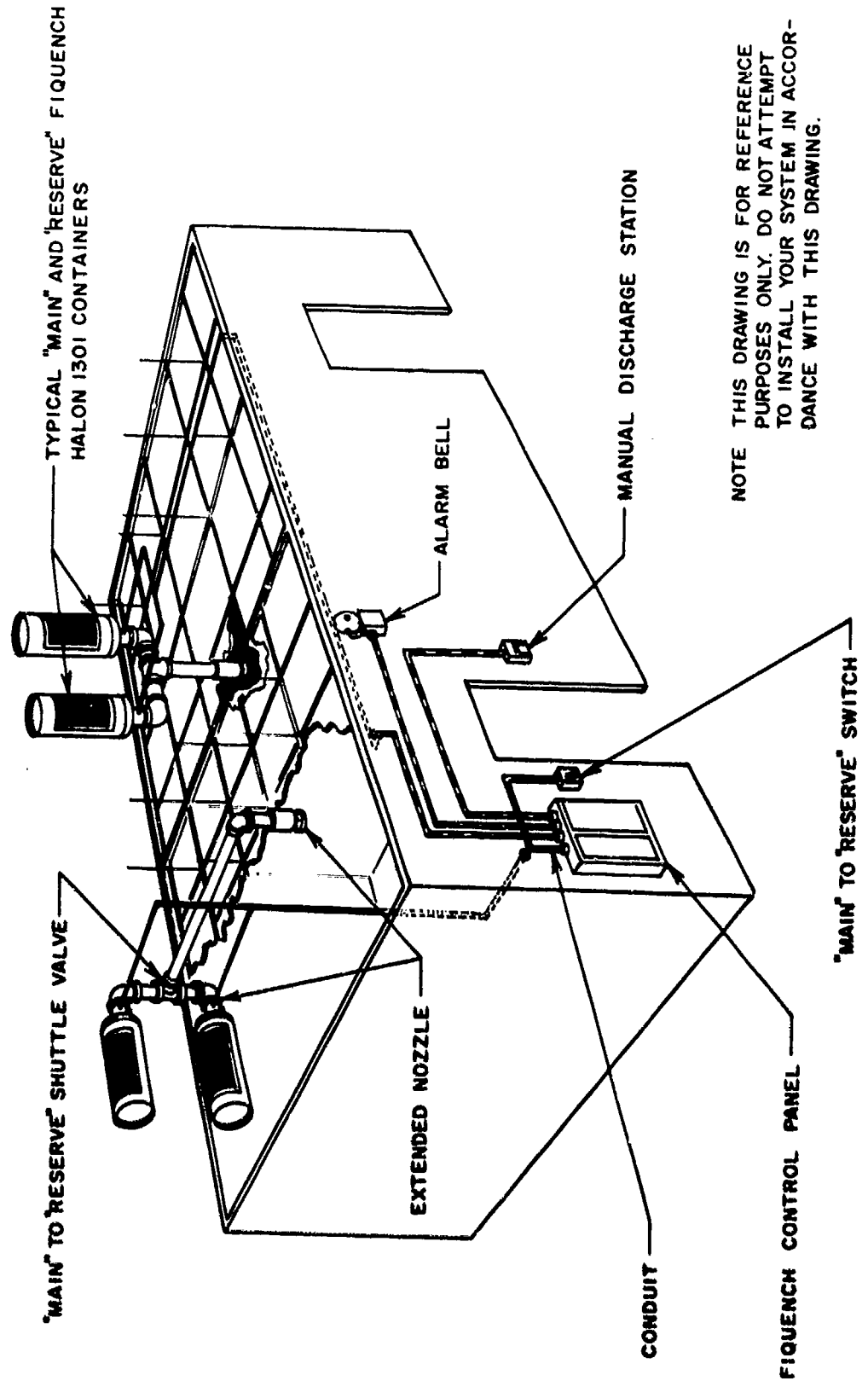


Fig 41 Halon systems (Fike Metal Products Corp.)





NOTE THIS DRAWING IS FOR REFERENCE PURPOSES ONLY. DO NOT ATTEMPT TO INSTALL YOUR SYSTEM IN ACCORDANCE WITH THIS DRAWING.



# PRIMAC<sup>®</sup> Ultra High Speed Fire Protection

The Grinnell PRIMAC fire protection system is applicable to hazards where the burning characteristics are such that extreme speed is essential if control or extinguishment is to be achieved. These hazards generally involve flammable materials which contain sufficient oxidizer for combustion within themselves but ordinary combustibles may also require a system of this type under certain conditions.

## PRIMAC COMPONENTS

A Grinnell PRIMAC system consists of one or more solid state photo-conductive cells which provide speed of light detection, a transistorized amplifier, an explosive actuated water control valve, and deluge type water discharge nozzles. Supervisory and test equipment are included in the system.

## PRIMAC IN OPERATION

The system operates in the following manner: Radiant energy from the fire, within certain wave lengths and above specified ambient light levels, reaches a photo-conductive cell, causing its resistance to change and allowing current to flow to a transistorized amplifier in the control panel. The amplifier increases the signal sufficiently to detonate the primer in the water control valve.

The explosive force of the primer releases a latch so that the water pressure in the supply piping can open

the valve. The line pressure is then impressed on the priming water in the piping down-stream of the control valve. This pressure is capable of rupturing or blowing off the closures which retain the priming water in the piping. Water discharges from the nozzles onto the fire at full line pressure.

The key to the success of this system is the speed of operation. The system is designed to detect a fire and discharge water in the fastest possible time within limits of reliability, economy and physical feasibility.

There are two time increments which effect the speed of operation. One is the equipment operating time from detection of the fire to the detonation of the primer in the water control valve. This is the fastest phase, having an operating time in the order of 2 or 3 milliseconds.

The second phase is the time from primer firing to water discharge at the nozzles. This increment is longer and will vary for different systems. The factors involved are dependent on system size, design and conditions at the hazard being protected.

Nonetheless, the entire system operates in a time interval measured in milliseconds, usually between 20 and 200.

## SPEED OF OPERATION

## DETECTION

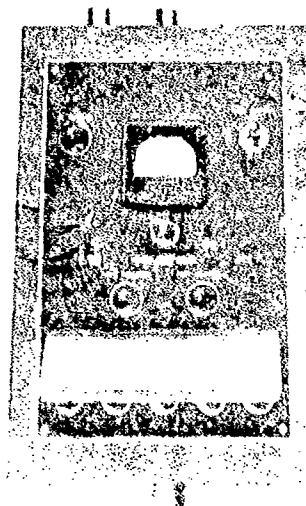
## ACTIVATING EXTINGUISH-AGENT



PRIMAC WATER CONTROL VALVE



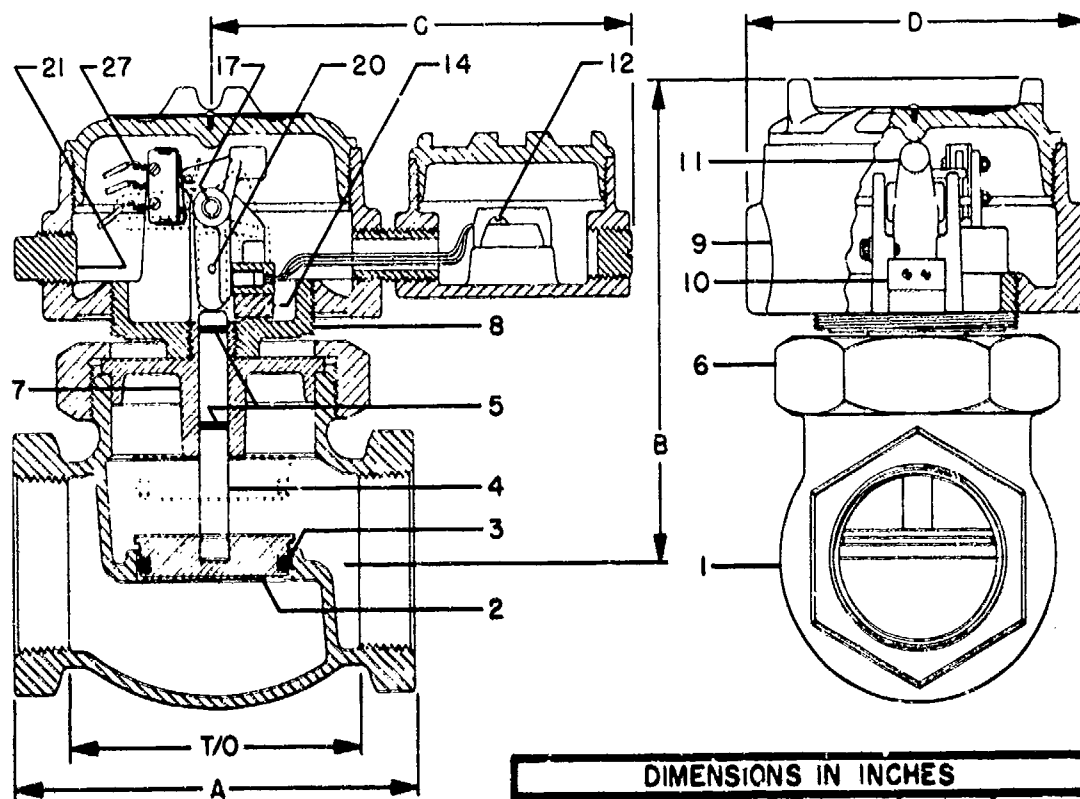
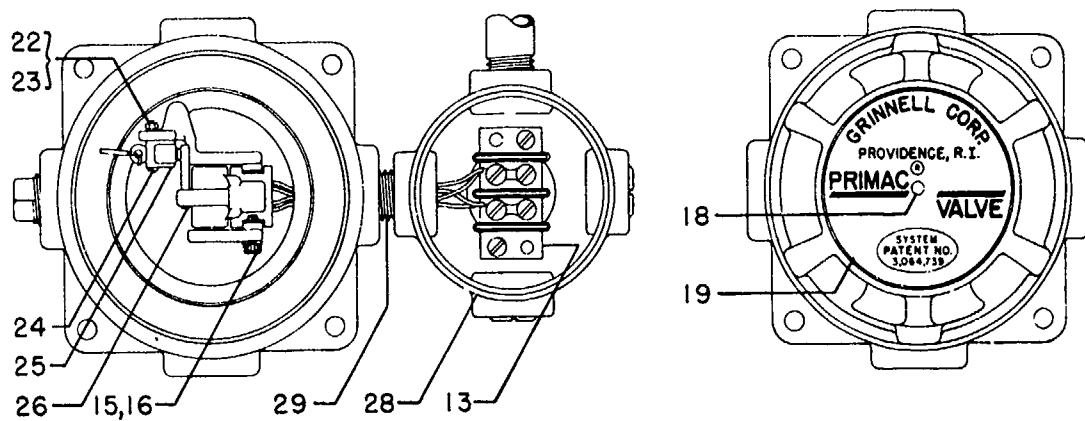
DETECTOR AND DELUGE NOZZLE



TEST PANEL

Fig 43 Ultra high-speed deluge systems





REFER TO REVERSE SIDE FOR LIST  
OF COMPONENT PARTS AND  
ORDERING PROCEDURE.

DIMENSIONS IN INCHES					
VALVE SIZE	A	B	C	D	TAKE OUT
2	5 11/16	7 1/2	7 1/8	5 13/16	4 7/16
2 1/2	6 7/8	7 3/4	7 1/8	5 13/16	5 1/8

## GRINNELL PRIMAC VALVE MODEL B-2

GRINNELL

(P-9) 4-28-69

Fig 44 Ultra high-speed deluge systems



**COMPONENT PARTS:**

- |  |   |
|--|---|
| 1 - BODY.  | 18 - DRIVE SCREW, NO. 4 x $\frac{3}{16}$ " LONG.  |
| 2 - PLUG.  | 19 - IDENTIFICATION DISC.   |
| 3 - O-RING, 1.600" I.D. x .210" CROSS SECTION FOR 2" VALVE; 2.225" I.D. x .210" CROSS SECTION FOR 2 $\frac{1}{2}$ " VALVE. | 20 - LATCH SHEAR PIN. (6 FURNISHED)   |
| 4 - SHAFT.   | 21 - PLUG, $\frac{1}{2}$ ", FIG. 787. (3 REQUIRED)  |
| 5 - O-RING, .364" I.D. x .070" CROSS SECTION. (2 REQUIRED)   | *22 - HEX NUT, NO. 4-40. (2 REQUIRED)   |
| 6 - BONNET NUT.  | *23 - SPRING LOCK WASHER FOR NO. 4 SCREW. (2 REQUIRED)  |
| 7 - BONNET.  | *24 - ROUND HEAD MACHINE SCREW NO. 4-40 x $\frac{3}{4}$ ". (2 REQUIRED)   |
| 8 - BONNET TOP.  | ◆25 - SWITCH, SINGLE POLE DOUBLE THROW CONTACTS, 15.0 AMPS. NON-INDUCTIVE LOAD, $\frac{1}{2}$ H.P. 125/250 V. A.C.      |
| 9 - JUNCTION CONDULET WITH COVER.  | *26 - RADIAL LOCKING PIN, $\frac{5}{32}$ " x 1"   |
| 10 - PRIMER HOLDER.  | *27 - ELECTRICAL LEADS, 18 GAGE, 60C, 600V., COLOR CODE: BLACK - COMMON, YELLOW - NORMALLY CLOSED, RED - NORMALLY OPEN. |
| 11 - LATCH.  | 28 - JUNCTION BOX, WITH COVER AND 3 PLUGS.  |
| 12 - ROUND HEAD MACHINE SCREW, NO. 10-32 x $1\frac{1}{4}$ " (2 REQUIRED)   | 29 - NIPPLE, $\frac{1}{2}$ " x CLOSE.   |
| 13 - TERMINAL BLOCK.   | ◆ OPTIONAL - FURNISHED ONLY WHEN SPECIFIED IN ORDER.  |
| 14 - BUMPER.   | * ACCESSORIES FOR SWITCH, ITEM 25, WHEN REQUIRED.   |
| 15 - SPRING LOCK WASHER, FOR NO. 8 SCREW.  |   |
| 16 - SOCKET HEAD CAP SCREW, NO. 8 - 32 x $\frac{1}{2}$ ".  |   |
| 17 - RADIAL LOCKING PIN, $\frac{5}{16}$ " x $1\frac{3}{8}$ "   |   |

**TO ORDER SPECIFY:**

GRINNELL (SIZE) PRIMAC VALVE, MODEL B-2, (SPECIFY WITH OR WITHOUT SWITCH). - - - - - (QUANTITY)

EACH PRIMAC VALVE OPERATION REQUIRES REPLACEMENT OF THE LATCH SHEAR PIN, ITEM 20; PRIMER HOLDER, ITEM 10 AND TWO PRIMERS.

ADDITIONAL QUANTITIES OF THESE ITEMS, AS REQUIRED, MUST BE ORDERED SEPARATELY AS FOLLOWS:

LATCH SHEAR PIN FOR USE WITH PRIMAC VALVE. - - - - - (QUANTITY)  
PRIMER HOLDER FOR USE WITH PRIMAC VALVE. - - - - - (QUANTITY)  
PRIMERS, HERCULES MK-131-O. (PACK IN WOODEN BOX WITH SAWDUST AND SHIP IN ACCORDANCE WITH ICC REGULATIONS.) - - - - - (QUANTITY)

**GRINNELL  
PRIMAC VALVE  
MODEL B-2**

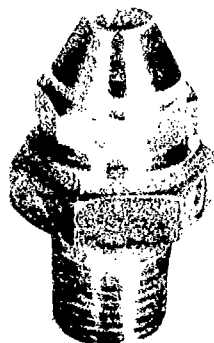
Fig 45 Ultra high-speed deluge systems





**GRINNELL**  
GRINNELL FIRE PROTECTION SYSTEMS COMPANY, INC.

## SPRINKLERS, NOZZLES AND ACCESSORIES / SECTION 4



• Mulsifyre projector



• Mulsifyre projector with cap

### Description

The Grinnell Mulsifyre Projector is an internal scroll type projector designed to produce a filled cone of water drops with long range and high velocity. Specially designed combinations of orifice sizes and scrolls minimize water usage but still provide total coverage over the protected area. The wide assortment of projectors available provides the necessary system design

### Mulsifyre Projectors

flexibility needed for Special Hazards Applications.

The Mulsifyre Projector can be used in either open or pre-primed systems. The Projector itself is open design. For use in pre-primed systems, the Mulsifyre Projector may be fitted with a blow-off cap, a rupture disc or both - depending on the system design. The blow-off cap or rupture disc permits priming the system with water so that water is discharged immediately upon actuation of the system control valve.

### Application

Grinnell Mulsifyre Projectors are used in deluge water spray systems for special hazards applications. Typical installations include transformers, chemical processing structures, process equipment, drying ovens, etc.

### Operation

Water flow to open type Mulsifyre Projectors is controlled by a deluge

valve in the main water supply line. When the deluge valve is actuated, water discharges from all Projectors in the system at the same time.

In pre-primed systems, water is held back by the blow-off cap or rupture disc. When the water control valve is actuated, the water supply pressure forces off the cap or breaks the rupture disc. Water is then immediately discharged on the hazardous area.

The coverage area of the Projectors is determined by the size and type of Projector chosen and the Projector position relative to the surface being protected.

### Features

- Heated or unheated areas
- Long range and high velocity
- Open or pre-primed systems
- U.L. listed
- FM approved



• Typical installation

New Issue May 1975

Fig 46 Ultra high-speed deluge systems



## PILOTEX DELUGE SPRINKLER SYSTEM

The PILOTEX Deluge Sprinkler System is a High Speed System using AUTO-SPRAY pilot operated nozzles.

Positive priming at fire main pressure and simultaneous opening of all nozzles connected to one pilot line make the PILOTEX Deluge System unique.

In severe fire conditions (where several standard sprinklers in a wet system will operate one at a time) the AUTO-SPRAY nozzles will open simultaneously. The pilot line interconnects all nozzles and keeps them closed by maintenance of pilot pressure taken from the fire main.

Detection and operation can be achieved in various ways:

1. By Rate-of-Rise - H.A.D.'s send a pneumatic pressure impulse to trip an "AUTO-SENTRY" release dumping pilot pressure. This type can be reset after operation.
2. By Fixed Temperature Units, such as sprinklers, installed on the pilot line at acceptable spacing. They must be of a type where the fusible element is not in direct contact with the water in the pilot line. These, if fused, must be replaced before restoring pilot pressure.
3. By Electronic Detection (thermostat, etc.) opening a solenoid-operated relief valve.
4. By manual means - either electrically by use of push button and solenoid valve or by manually opening a ball valve.

Because of the speed of operation this system is particularly suited for the protection of special hazards. It has the advantage of a primed deluge system, but it may be installed as a modular section of a large sprinkler system, such as a deluge extension to a wet pipe system.

Fire alarm may be obtained by use of Water Motor Alarm, Water Flow Indicator, Pressure Switch on the pilot line or a switch on the relief valve mechanism.

To obtain maximum speed, all entrapped air must be bled from the pilot line and from the fire main piping at the highest point. When nozzles are installed above the pilot line piping, they must be provided with a bleed so that entrapped air can be bled off. (See section 1 for details.)

## WATER SUPPLY

For maximum efficiency an adequate and clean water supply is necessary. It is important that strainers be used on the pilot line and on the supply line, and that these strainers be inspected and cleaned periodically.

Where a clean water supply is not possible, or where salt water is used for fire main pressure, the pilot pressure supply should be from a separate, clean, fresh water source. In this case pilot pressure should be maintained 5 - 10 PSI above the maximum fire main pressure anticipated.

**Caution:** In case of water supply pressure failure or shut off, either by Controlling Gate Valve or a remote Gate Valve, it is essential that pressure be restored in the pilot line before it is restored in the fire main line. If this is not done, water will flow through the nozzles temporarily, until the restricted pilot line seals off the flow. The pilot line restriction is small enough to prevent the pilot pressure from keeping up with the pilot pressure release flow upon tripping.

## TESTING

**Note:** Testing a PILOTEX system for operation involves all nozzles on one pilot line. The complete operational test should be made at least once a year.

System may be tripped by applying heat to H.A.D. with a test lamp, by fusing an FTU or by solenoid valve operation.

If a complete operational test is not possible at least the release mechanism and the detectors should be tested periodically. For this, water pressure may be shut off and piping drained. Pilot line pressure is maintained because it is taken from below the Main Control Valve. Upon tripping the pilot pressure release, pressure is released from the nozzles and the nozzles may drip slowly under certain conditions. When resetting system after fire alarm has been reset and pilot pressure has been restored, pilot pressure must be restored before water pressure is restored.

A water flow test may be made by opening the drain valve. This will not affect the model as long as fire main and pilot pressure come from the same source and any drop in pressure does not affect the system.



Automatic Sprinkler CORPORATION OF AMERICA

1170 U.S.A. 248 24

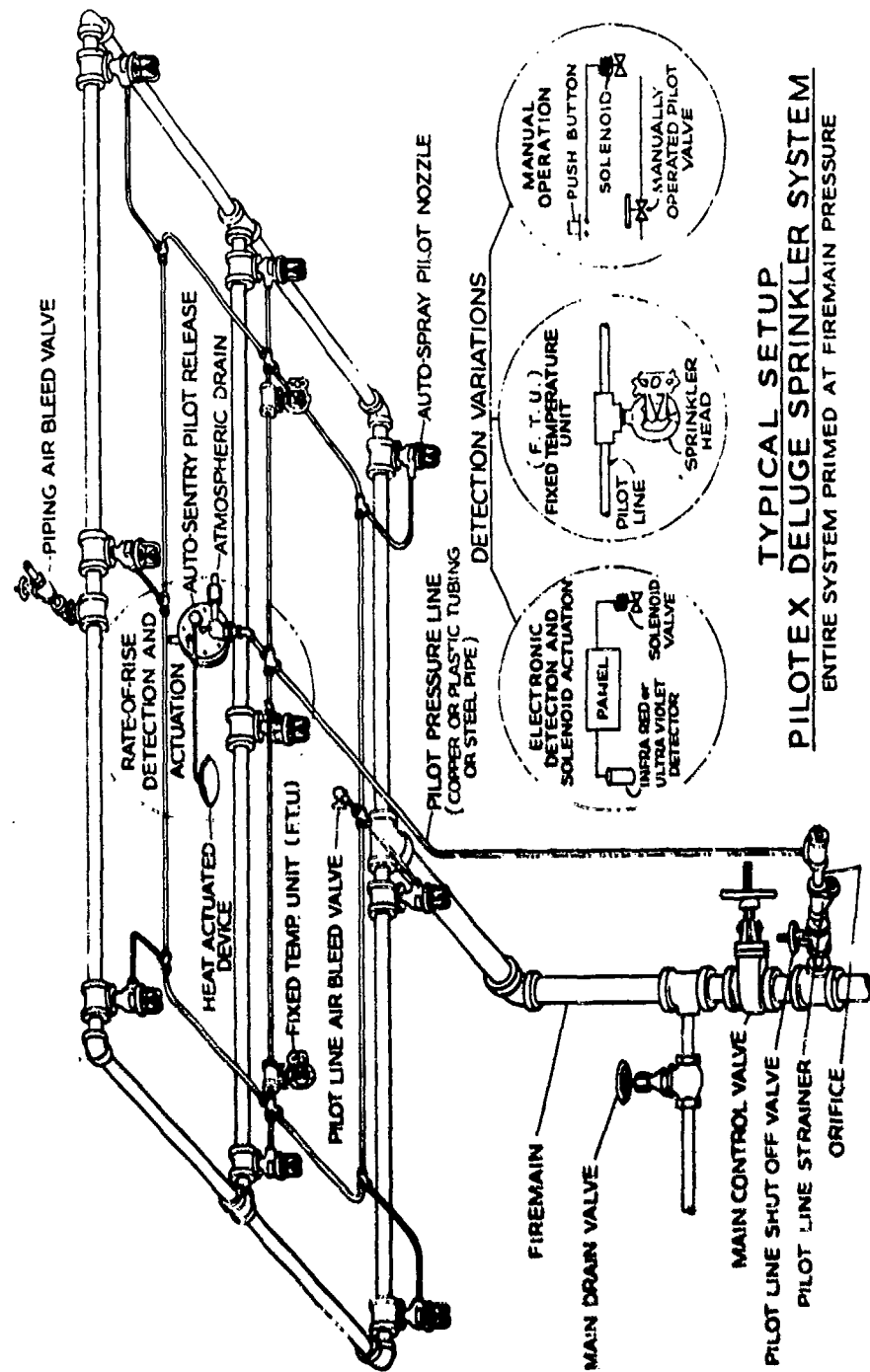
Fig 47 Ultra high-speed deluge systems



# PILOTEX SPRINKLER SYSTEM

N-6

*Automatic Sprinkler* CORPORATION OF AMERICA



## TYPICAL SETUP PILOTEX DELUGE SPRINKLER SYSTEM ENTIRE SYSTEM PRIMED AT FIREMAIN PRESSURE

*Automatic Sprinkler* CORPORATION OF AMERICA

LITHO U.S.A. 4-64 24

Fig 48 Ultra high-speed deluge systems



## SYSTEM DESIGN SUGGESTIONS

In order to get proper operation of the AUTO-SPRAY nozzle a minimum flow-pressure at each nozzle is required. See Ordering Procedure.

It is therefore important to design the system hydraulically and to ascertain adequate water supply.

Where large areas are to be protected, it is suggested that the area be divided into smaller sections of approximately 20 nozzles. This sectioning is for the pilot line and release. The water supply piping can be of standard design.

The pilot release for each section should be centrally located so that the distance from each nozzle to the pressure release is about the same.

H.A.D.'s or other fire detectors can be placed where they will perform to their best advantage.

## ORDERING PROCEDURE

## Caution:

In determining orifice size consider the pressures required to operate the AUTO-SPRAY nozzles.

3/8" and 7/16" orifice - Sprinkler or Spray Cone pattern - ..... 20 PSI min.

17/32" orifice - Sprinkler or Spray cone pattern ..... 30 PSI min.

90° or 180° - Flat Spray - ..... 20 PSI min.

3/4" - 1" - 1-1/4" - Male Adapter - ..... 30 PSI min.

These pressures are flow pressures at each nozzle.

Not Listed by Underwriters' Laboratories, Inc.  
or Approved by Factory Mutual Engineering Division.



Automatic Sprinkler CORPORATION OF AMERICA

LITHO U.S.A. 2-60 24

Fig 49 Ultra high-speed deluge systems



**AUTO-SPRAY PILOT NOZZLE**

The development of the pilot pressure operated nozzle makes possible a new type of high speed fire protection system.

The AUTO-SPRAY Pilot Nozzle is designed to seal off fire main pressure at the nozzle by use of pilot pressure. When pilot pressure is relieved, all AUTO-SPRAY nozzles connected to one pilot line open instantly and simultaneously.

When pilot pressure is restored, the nozzle closes. Fire main pressure and pilot pressure are taken from the same source so that the differential remains proportionally unchanged, thus preventing false operation from fire main pressure variations.

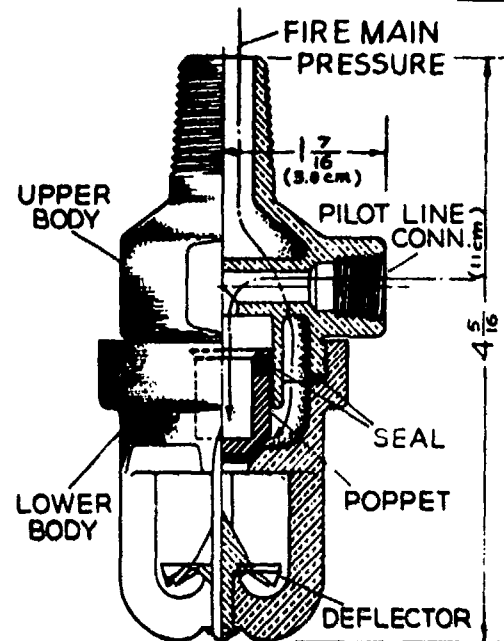


Fig. 1

**DETAILED DESCRIPTION - See Fig. 1**

The AUTO-SPRAY nozzle consists of a two piece body threaded together and sealed with an "O" ring. The upper half is threaded 1/2" IPT for insertion in standard pipe fittings (see also union tail piece - Fig. 2 and 3) and has a second connection for the pilot line through which a cylinder and poppet receive pilot pressure. The poppet has an "O" ring seal and a rubber seat on its face which seats against the orifice located in the lower half of the body.

**METHOD OF OPERATION**

When the nozzle is in its normally closed position the poppet is held against the discharge orifice by pressure within the poppet cylinder. When pilot line pressure drops, the fire main pressure overcomes the differential, forces the poppet up, opening the sprinkler orifice and instantly starts full discharge.

When pilot pressure is restored the poppet returns, even against fire main pressure.

**PRESSURE REQUIREMENT**

In order to properly operate the AUTO-SPRAY nozzle at the desired speed a minimum flow pressure at each nozzle is required. See Ordering Procedure.

**VARIATIONS**

The AUTO-SPRAY Nozzle is available with several variations in orifice size, spray or sprinkler patterns, inlet (tailpiece) connection, pilot line connection and outlet size (adapter).

**Series 165**

Main body with 1/2" IPT male fire main inlet connection and 1/4" IPT pilot connection.

165-6000 - Wide Cone - Sprinkler pattern with 3/8" - 7/16" or 17/32" orifice

165-7000 - Narrow Cone - Spray pattern with 3/8" - 7/16" or 17/32" orifice

165-8000 - Flat Spray - 90° or 140°

16"-WEX - Male Adapter

1/4" for 667 or 667WA

1" for 668 or 668WA

1-1/4" for 669 Spray Nozzle

May be used with Foam Water, antifoam, or nozzles and other discharge devices of applicable colors.



Automatic Sprinkler CORPORATION OF AMERICA

LITHO U.S.A. 400-20

Fig 50 Ultra high-speed deluge systems



# AUTO-SPRAY PILOT NOZZLE

*Automatic Sprinkler* CORPORATION OF AMERICA

J-28

## Series 170

Main body with union tail piece for 1/2" IPT male or female - brazing or threaded, (this pattern or type normally specified in U. S. Navy Ship Requirement) or 1/2" IPT male or female - threaded malleable iron.

170-6000 - Wide Cone - Sprinkler pattern with 3/8" - 7/16" or 17/32" orifice

170-7000 - Narrow Cone - Spray pattern with 3/8" - 7/16" or 17/32" orifice

170-8000 - Flat Spray - 90° or 180°

170-9000 - Male Adapter  
3/4" for 667 or 667 WA  
1" for 668 or 668 WA  
1-1/4" for 669 Spray Nozzles

May be used with Foam Water sprinklers or nozzles and other discharge devices or applicators.

Standard pilot connection is 1/4" IPT - but all variations can be ordered with 1/8" IPT or with 7/16" - 20 straight thread gasket seal (see Fig. 2) MIL-STD-16142 - Ships.

On special order a bleed is available on all variations (see Fig. 2). This is for cases where nozzles are installed above the pilot line and bleeding must be done at the highest point.

**FLAT SPRAY - 90° or 180°**  
**GROUP SYMBOL NO. 165-8000 or 170-8000**

A variation of the AUTO-SPRAY Nozzle is the attachment of a special nose in place of the regular deflector. It produces a flat spray pattern capable of reaching into narrow spaces and is available in 90° or 180° angle.

The orifice disc can be rotated within the cap, so that the flat pattern can be adjusted to match the angle of the hazard.

Designed especially for missile washdown while stored in horizontal position aboard ship, this flat spray nozzle can be used to good advantage in other than military installations.

Possible uses are: Cooling tower protection, water curtain, and for other hard to reach, narrow spaces.

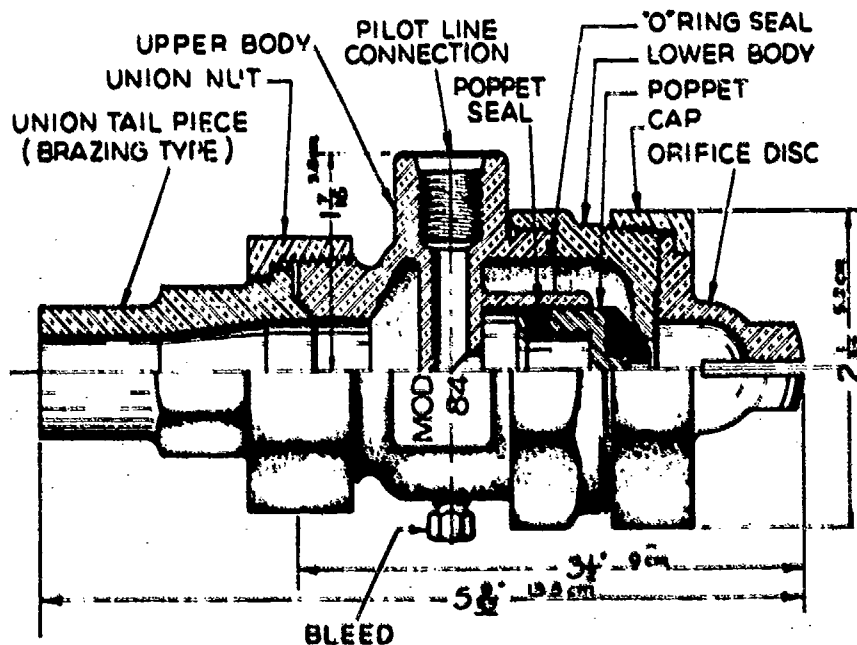


Fig. 2

*Automatic Sprinkler* CORPORATION OF AMERICA ©

U.S. PAT. 2,800,000

Fig 51 Ultra high-speed deluge systems



# A10 DELUGE VALVE

Fast Response Pressure Release Device



## IMPORTANT FEATURES

- Ultrafast Response
- Valve May Be Actuated by Any Sensing Device Having Normally Open to Closed Contacts
- Interfaces with All ANSI and ASA Piping Flanges
- Sizes 1 1/2 to 12" Diameter Metric Sizes Also Available
- Wide Selection of Materials
- Valve May Be Rearmed in the Field
- Dual Actuating Circuits Available for Redundancy
- Fragmenting and/or Non-Fragmenting Rupture Disc Available
- Custom Designed to your Application

## INTRODUCTION

The Fike Deluge Valve was first introduced in 1965 to provide an ultra fast opening valve for use in fire control applications, venting runaway reactions, and shock tube testing. The versatility and reliability of this device, since its conception, has opened many new frontiers never before imagined.

## DESCRIPTION

The Fike A10 series Deluge Valve is a pyrotechnic field reloadable device designed to explosively open a Rupture Disc on command. The valve consists of a conventional or pre-cored Rupture Disc, clamped between two flanges, a specially designed explosive charge fixed to the disc, and a detonator assembly.

Upon command, an electric current actuates the detonator which provides the energy required to actuate the shape charge on the disc. The resulting shock forces the disc open, allowing an unobstructed path of flow thru the valve.

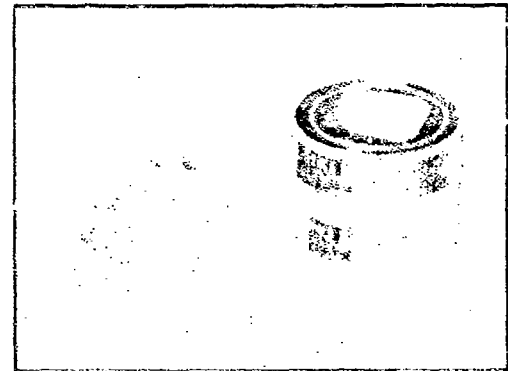
## APPLICATION

Fike Engineers custom design the Deluge Valve to each system application. Careful consideration is given to system media, operating temperature, desired actuation pressure, and interface details for the most economical valve design.

The standard A10 series Deluge Valve configuration is adequate to handle most system requirements. For unusual requirements such as high temperature (above 170°F continuous) a non standard air or water cooled configuration is available. Dual detonator assemblies can be provided where system redundancy is required. Special high-speed detonator assemblies are available for "fast-response" applications.

Continuous research and development enables Fike to provide a product which can be depended upon to give the ultimate in fast response pressure release.

Fike Engineers are available to design and supervise the installation of single valve applications to complete Deluge Valve releasing systems.



U. S. Patent No. 3,109,563

FM Approved

## FUNCTION

The Fike A10 Deluge Valve will handle any liquid or gas media. The basic function is to relieve a system pressure when an emergency situation arises. The A10 Deluge Valve is actuated by closing an electrical circuit to the detonator assembly. Many methods of circuit closure are available such as:

1. Manual Push Button
2. Temperature Switch
3. Infrared or Ultraviolet detection
4. Pressure Switch
5. Proximity Switch
6. Any device which provides normally open to closed electrical contacts.



## Engineering Data and Specifications

Fike Deluge Products Corporation • Blue Springs, Missouri 64015 • (816) 729-3405

Fig 52 Rupture disc valves



## ELECTRICAL WIRING

Multiple Deluge Valves may be wired in series or parallel circuits as required provided the minimum recommended 5 amp firing current is available at all detonator assemblies.

The A10 Deluge Valve can be supervised on a continuing basis, however, the monitoring current must not exceed 12 ma (dc).

A typical wiring diagram of the A10 Deluge Valve releasing system is shown in fig. 1. The low voltage electronic control equipment shown is available as an option.

## INSTALLATION

A detailed Installation and Maintenance Manual is supplied with each valve assembly.

Although the explosive materials (PETN) used in the Deluge Valve are extremely safe when compared to other explosive devices, the installer should have a working knowledge of pyrotechnics.

The valve assembly and detonator must be handled with care at all times to prevent damage to the Rupture Disc or pyrotechnic components.

## MAINTENANCE

The A10 Deluge Valve is virtually maintenance free due to its unique design and configuration. A visual periodic maintenance inspection should be performed based upon the application. Marginal temperature and pressure conditions should be observed as a standard maintenance practice.

## ORDERING

When placing an order or requesting additional information, specify the following data:

- A. Media
- B. Normal System Operating Pressure
- C. Required Release Pressure
- D. Power Available (Electrical)
- E. Desired Response (Opening Time)
- F. Flow Requirements
- G. Fragmenting/Non-Fragmenting
- H. Size of Valve and ANSI Rating Required
- I. Materials
- J. Single or Dual Detonators

## SHIPPING INFORMATION

The detonator assemblies and loaded Rupture Disc are shipped as class "C" explosives. Shipping weight and cost data are available upon request. The Fike Deluge Valve can be shipped via truck, boat, rail or air freight.

## TECHNICAL DATA

All data & specifications are on the standard A10 Deluge Valve.

PART	MATERIALS
Base & Holddown Flanges	Carbon Steel
Assembly Clips	Stainless Steel
Preassembly Screw	Alloy Steel
Conventional Rupture Disc (fragmenting)	Stainless Steel
Scored Rupture Disc (non-fragmenting)	Stainless Steel
Detonator Assembly	Stainless Steel
Explosive Cap	PETN
Explosive Shaped Charge	PETN
Explosive Train	PETN
"O"-Ring	Buna N
Finish (outside)	Paint, Dark Grey
Label & Tag	Aluminum

Do not in any way attempt to use this technical sheet to install or maintain the A10 Deluge Valve.

Note: The entire electrical system must be R. F. shielded at all times.

## SPECIFICATIONS

Pressure Rating	150 lb. Thru 2500 lb. ANSI (ASA)
Explosive Temperature Limits	40°F to 170°F Max.
Opening Time	5-6 milliseconds (Std) faster see options
Flow-Indicator	Arrow on label
Burst Pressure	As required up to 3,000 PSIG
Non-Fragmenting (flat seat)	Min Partial contamination
Fragmenting (30° seat)	Entire disc may be ejected
Sizes 1 1/2" Thru 12"	See Size Chart
Field Reloadable	Consult Installation Manual
A.C. Power	Not recommended

## OPTIONAL MATERIALS

Rupture Disc	Valve Body
Aluminum	Carbon Steel
Hastelloy	Stainless Steel
Inconel	Other materials upon request
Monel	
Nickel	
Stainless Steel	

## Typical Wiring Diagram (using Fike equipment)

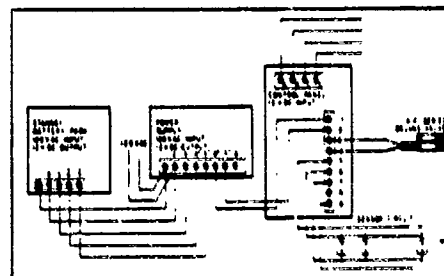
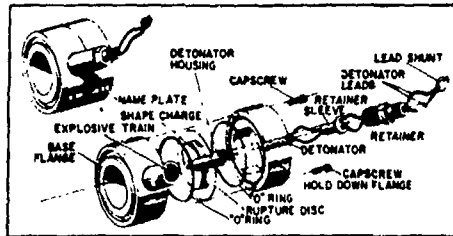


Fig 53 Rupture disc valves (Fike Metal Products Corp.)



### Exploded view



### STANDARD DETONATOR SPECIFICATIONS

A1503-6	PETN Explosive	
No-Fire current	0.2 Amps	
All-Fire current	.6 Amps	
Average firing time	3.8 M. S. @ 5.0 Amps	
Approximate firing time	1-2 M. S. @ 10.0 Amps	
Resistance	.44 ohms $\pm$ .25 ohms	
Minimum electrical energy required for firing	.02 Joule using 40 mfd. capacitor	
Temperature Range	215°F for 6 hrs. Max 200°F for 24 hrs. Max. 70°F for 5 years. Max.	NOTE, Contact Fike Engineering for temperatures less than 40°F

## OPTIONAL DETONATORS

A1503-7	Fast functioning	Operating in less than 1 ms.
A1503-10	High temperature	For temperature above 70°F
A1503-6	Dual Detonators are available in valve sizes 2" and up.	

### EXPLOSIVE SPECIFICATIONS

Velocity 6800 Meters/Sec  
Density 1.48 Grms./cc.  
MIL E-46676 MU  
Rubber Base PETN

**FIRING POWER AVAILABLE**

**OZONATOR**  
☐ SINGLE  
☐ DUAL

**NORMAL SYSTEM OPERATING PRESSURE**

**DESIRED RESPONSE (OPENING TIME)**

**BACK PRESSURE**  
☐ GALLONS PER MINUTE  
☐ STANDARD CUBIC FT.  
☐ POUNDS PER HOUR  
☐ FRAGMENTING  
☐ NON-FRAGMENTING

**REQUIRED RELEASE PRESSURE**

**VALVE MATERIAL**

**VALVE SIZE AND ANSI RATING REQUIREMENTS**

**LINE SIZE O.D.**

**LINE SIZE I.D.**

**WORK SHEET A-10 VALVE**

**MEDIA TO BE PROTECTED**

**FLOW**

**NOTES**

**Fig 54 Rupture disc valves (Fike Metal Products Corp.)**

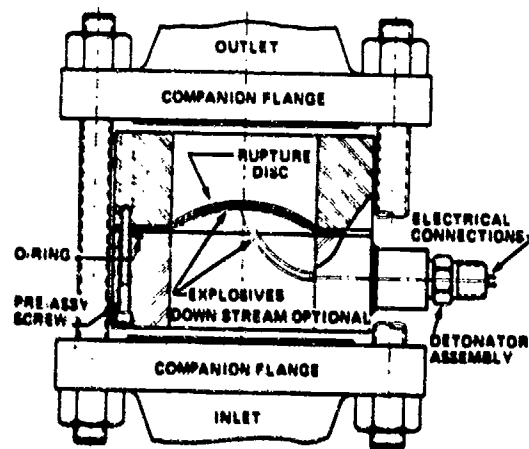


# DIMENSIONS FOR A10 SERIES DELUGE VALVE

Nominal Size	ANSI (ASA) Rating	Max. Rating	Outside Diameter	Approx. Overall Ht.	
				Non Frag.	Frag.
1-1/2	150	275	3-1/4	3-1/8	3-1/8
1-1/2	300	720	3-5/8	3-1/8	3-1/8
1-1/2	600	1440	3-5/8	3-1/8	3-1/8
1-1/2	900	2160	3-5/8	3-1/8	3-1/8
1-1/2	1500	3600	3-5/8	3-1/8	3-1/8
1-1/2	2500	6000	4-1/2	3-1/8	3-1/8
2	150	275	4	3-1/2	3-3/8
2	300	720	4	3-1/2	3-3/8
2	600	1440	4	3-1/2	3-3/8
2	900	2160	5-1/2	3-1/2	3-3/8
2	1500	3600	5-1/2	3-1/2	3-3/8
2	2500	6000	5-1/2	3-1/2	3-3/8
3	150	275	5-1/4	4-1/8	3-3/8
3	300	720	5-3/4	4-1/8	3-3/8
3	600	1440	5-3/4	4-1/8	3-3/8
3	900	2160	6-1/2	4-1/8	3-3/8
3	1500	3600	6-1/2	4-1/8	3-3/8
3	2500	6000	7-1/2	4-1/8	3-3/8
4	150	275	6-3/4	4-5/8	3
4	300	720	7	4-5/8	3
4	600	1440	7-1/2	4-5/8	3
4	900	2160	8	4-5/8	3
4	1500	3600	8	4-5/8	3

Nominal Size	ANSI (ASA) Rating	Max. Rating	Outside Diameter	Approx. Overall Ht.	
				Non Frag.	Frag.
6	150	275	8-5/8	5-3/8	3-3/8
6	300	720	9-3/4	5-3/8	3-3/8
6	600	1440	10-3/8	5-3/8	3-3/8
6	900	2160	11	5-3/8	3-3/8
6	1500	3600	11	5-3/8	3-3/8
8	150	275	10-7/8	6-3/8	3-1/2
8	300	720	12	6-3/8	3-1/2
8	600	1440	12-1/2	6-3/8	3-1/2
8	900	2160	13-3/4	6-3/8	3-1/2
8	1500	3600	13-3/4	6-3/8	3-1/2
10	150	275	13-1/4	7-5/8	3-5/8
10	300	720	14-1/8	7-5/8	3-5/8
10	600	1440	15-5/8	7-5/8	3-5/8
12	150	275	16	8-3/8	3-3/4
12	300	720	16-1/2	8-3/8	3-3/4
12	600	1440	17-7/8	8-3/8	3-3/4

Other sizes, pressures, and special configurations on request.



Fike A10 Series Deluge Valve



## Engineering Data and Specifications

Fike Metal Products Corporation • Blue Springs, Missouri 64015 • (816) 239-3406

Fig 55 Rupture disc valves



# CLAYTON *Hydraulic* VALVES

## RATE OF FLOW CONTROLLER

Clayton 40-01 Series

The Clayton 40-01 Rate of Flow Controller maintains a constant flow rate regardless of changing line pressure.

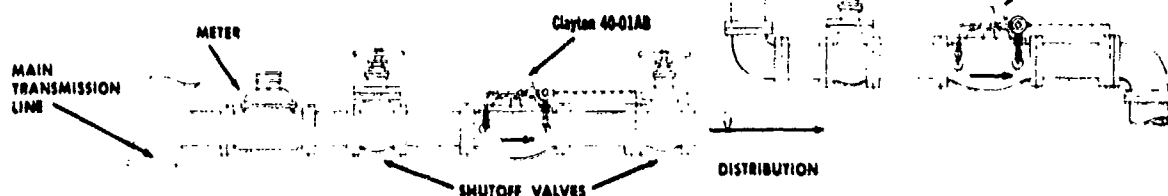
It is a hydraulically-operated, pilot-controlled, diaphragm type globe valve. The pilot control is actuated by the differential pressure produced across an orifice plate installed downstream of the valve. Accurate control is insured as very small changes in the controlling differential produce immediate corrective action of the main valve. Rate of flow is adjustable by varying the spring loading on the control. The standard controller includes a calibrated orifice plate and holder that is installed one to five pipe diameters downstream of the valve.



### Typical Applications

Typical arrangement of pressure type filter effluent controller. Maintains constant flow rate as head loss through filter varies.

Installed where water supply to a system must be limited to a pre-set flow to prevent lowering the supply pressure. Easily set to maintain the maximum allowable flow rate.



### Capacity Chart

VALVE SIZE	MINIMUM FLOW RATE (GPM) (H <sub>2</sub> O)	NORMAL MAXIMUM FLOW RATE (GPM)** (H <sub>2</sub> O)
2"	15	208
2 1/2"	20	300
3"	30	460
4"	50	800
6"	115	1800
8"	200	3100
10"	300	4900
12"	400	7000
14"	500	8500
16"	650	11000

\*\*Maximum normal flow based on pipeline velocity of 20 feet per second.

#### NOTE:

Caution should be exercised when this valve is used to operate at the normal maximum flow rates.

The pressure loss across the valve and orifice plate combined should be calculated so as not to exceed the maximum operating pressure available in the system.

Flow rate through the valve can be adjusted over a 4:1 range for any specific orifice bore provided the minimum and maximum flow rates selected do not exceed the values noted in either the first or third column of the capacity table.

### Specifications

VALVE SIZES	2--16" flanged
END DETAILS	125 and 250 ANSI B16.1
PRESSURE RATINGS	125 Class -- 175 psi Max. 250 Class -- 300 psi Max.
TEMPERATURE RANGE	Water: to 180° F. Max.
MATERIALS	Main valve body and cover: Cast Iron ASTM A48 Main valve trim: Brass QQ-B-26 & Bronze ASTM B61 Pilot controls: Bronze ASTM B-62 Pilot control trim: Stainless Steel Bar 303 Orifice plate: Stainless Steel 303 Rubber parts: Buna N Other materials available: Cast Steel, Bronze, Aluminum
ADJUSTMENT RANGE	Low flow equals one-fourth maximum flow.

Fig 56 Rate-of-flow devices (Cla-Valve Co.)



## Purchase Specifications

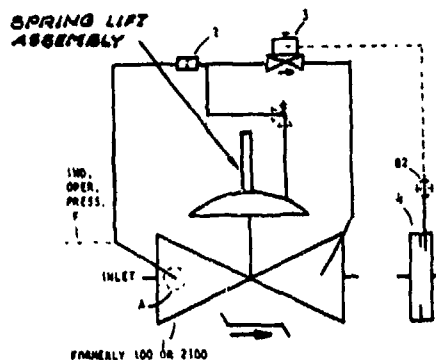
The valve shall maintain a constant rate of flow regardless of fluctuations in upstream pressure. This valve shall be a hydraulically-operated, pilot-controlled, diaphragm type globe valve. The main valve shall have a single removable seat and a resilient disc. The valve stem shall be guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat.

No external packing glands are permitted. The diaphragm shall not be used as a seating surface, and there shall be no pistons operating the main valve or any pilot controls.

The pilot control shall be a direct-acting diaphragm valve designed to close when the actuating differential increases beyond the spring setting. The actuating differential pressure shall be produced by a thin-edge orifice plate installed in an orifice flange located downstream of the valve.

Valve shall be similar in all respects to the Clayton 40-01 RATE OF FLOW CONTROLLER as manufactured by Cla-Val Co., Newport Beach, California, or approved equal.

### SCHEMATIC DIAGRAM ....



#### RATE OF FLOW CONTROLLER

ITEM	DESCRIPTION
1	CLAYTON 100-01 (Globe or Angle) HYTROL
2	X50C RESTRICTION ASSEMBLY
3	CDHS-18 DIFFERENTIAL CONTROL
4	X52A-1 ORIFICE PLATE ASSEMBLY

#### OPTIONAL FEATURES:

ITEM	DESCRIPTION
A	X46 FLOW CLEAN STRAINER

CATALOG NUMBER EXPLANATION:  
40-01 BASIC VALVE OPTIONAL  
ITEMS ARE THEN ADDED

EXAMPLE: Clayton 40-01AB is  
basic valve with X46 Flow  
Clean Strainer and CK2  
Shutoff Cocks

SPECIFY WHEN ORDERING:  
1. Globe or Angle  
2. Screwed or Flange  
3. Pressure Class  
4. Body Trim Material  
5. Adjustment Range  
6. Rate of Flow Control  
7. Optional Features Desired

### Dimensions

#### DIMENSIONS IN INCHES

VALVE SIZE IN INCHES	2	3	4	6	8	10	12	14	16
A 125 & 150 FLANGED	9 1/4	11 1/4	13 1/4	15 1/4	17 1/4	19 1/4	21 1/4	23 1/4	25 1/4
250 & 300 FLANGED	10	11 1/4	13 1/4	15 1/4	17 1/4	19 1/4	21 1/4	23 1/4	25 1/4
B	3 1/4	4 1/4	5 1/4	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4
C	10 1/4	11 1/4	12 1/4	13 1/4	14 1/4	15 1/4	16 1/4	17 1/4	18 1/4
D	2 1/4	3 1/4	4 1/4	5 1/4	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4
E 125 & 150 FLANGED	4 1/4	5 1/4	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4	12 1/4
250 & 300 FLANGED	5 1/4	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4	12 1/4	13 1/4
F 125 & 150 FLANGED	3 1/4	4 1/4	5 1/4	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4
250 & 300 FLANGED	4 1/4	5 1/4	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4	12 1/4
G	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4	12 1/4	13 1/4	14 1/4

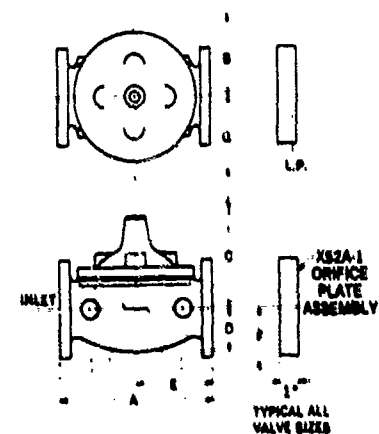


Fig 57 Rate-of-flow devices (Cla-Valve Co.)





# GRINNELL

GRINNELL FIRE PROTECTION SYSTEMS COMPANY, INC.

## SPRINKLERS, NOZZLES AND ACCESSORIES / SECTION 4



• Mulsifyre projector



• Mulsifyre projector with cap

### Description

The Grinnell Mulsifyre Projector is an internal scroll type projector designed to produce a filled cone of water drops with long range and high velocity. Specially designed combinations of orifice sizes and scrolls minimize water usage but still provide total coverage over the protected area. The wide assortment of projectors available provides the necessary system design

### Mulsifyre Projectors

flexibility needed for Special Hazards Applications.

The Mulsifyre Projector can be used in either open or pre-primed systems. The Projector itself is open design. For use in pre-primed systems, the Mulsifyre Projector may be fitted with a blow-off cap, a rupture disc or both – depending on the system design. The blow-off cap or rupture disc permits priming the system with water so that water is discharged immediately upon actuation of the system control valve.

### Application

Grinnell Mulsifyre Projectors are used in deluge water spray systems for special hazards applications. Typical installations include transformers, chemical processing structures, process equipment, drying ovens, etc.

### Operation

Water flow to open type Mulsifyre Projectors is controlled by a deluge

valve in the main water supply line. When the deluge valve is actuated, water discharges from all Projectors in the system at the same time.

In pre-primed systems, water is held back by the blow-off cap or rupture disc. When the water control valve is actuated, the water supply pressure forces off the cap or breaks the rupture disc. Water is then immediately discharged on the hazardous area.

The coverage area of the Projectors is determined by the size and type of Projector chosen and the Projector position relative to the surface being protected.

### Features

- Heated or unheated areas
- Long range and high velocity
- Open or pre-primed systems
- U.L. listed
- FM approved

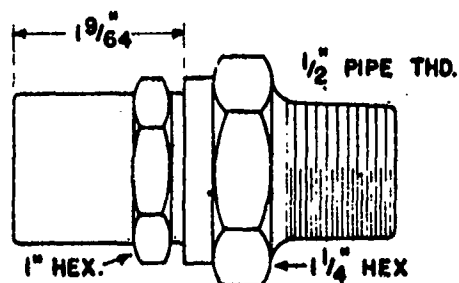


• Typical installation

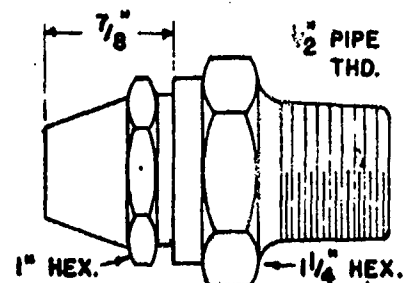
New Issue May 1975

Fig 58 Nozzles

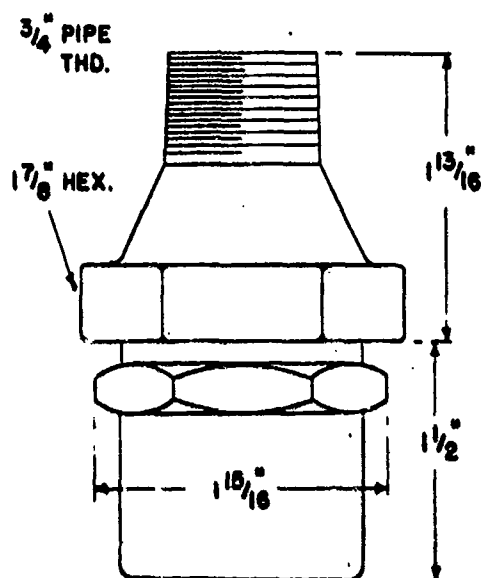




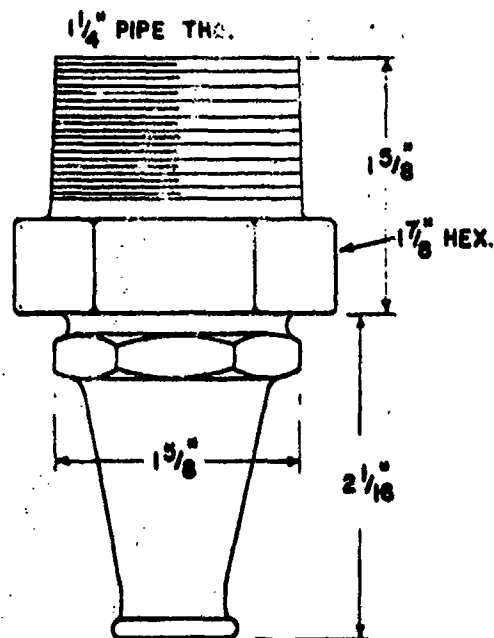
R-1-100-12 (GREEN)



R-1-60-7 (BLUE)



R-1-30-29



R-1-30-44  
R-1-45-41

IN THE DESIGNATION OF THESE PROJECTORS, R DENOTES A  
CAST SCROLL. FOR EXPLANATION OF OTHER FIGURES, SEE  
PRECEDING PAGE.

## GRINNELL MULSIFYRE PROJECTORS

GRINNELL COMPANY INC.

4-19-54

Fig 59 Nozzles



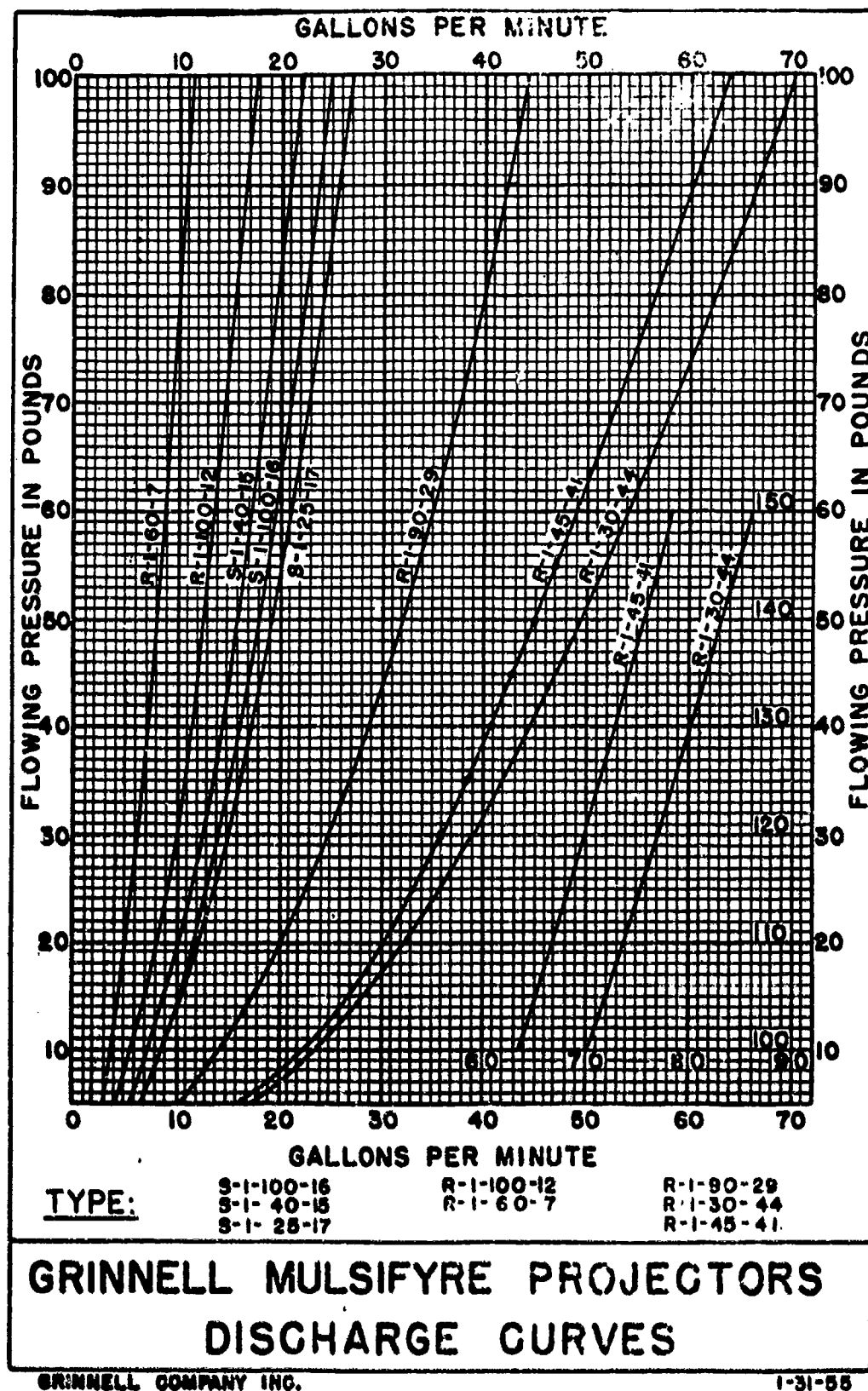
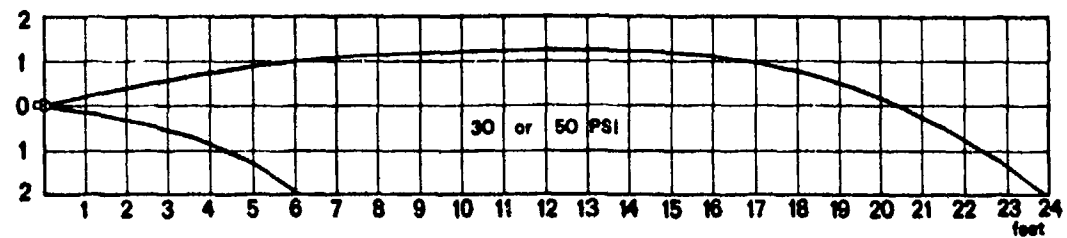


Fig 60 Nozzles

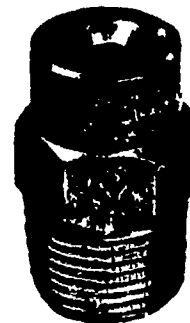
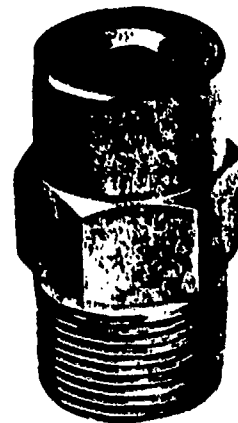


**NOZZLES**

J-49

**"AUTO-SPRAY" NOZZLE TYPE LT  
LONG THROW PATTERN**

Long Throw type "AUTO-SPRAY" NOZZLES produce a 40° conical pattern over a great horizontal distance from the nozzle. They are available in three orifice sizes for connection to 1" and 1-1/4" pipe sizes. See photo and specifications shown below for details.



- FULL CONE
- HIGH VELOCITY
- DIRECTIONAL

"AUTO-SPRAY" NOZZLES are listed by Underwriters' Laboratories, Inc., and approved by the Factory Mutual System.

NOZZLE NUMBER	PIPE CONN (MALE)	ORIFICE K FACTOR	FLOW RATE IN G.P.M. FOR GIVEN P.S.I.										
			10	15	20	30	40	50	60	70	80	90	100
15 LT	1"	2.8	8.9	10.8	12.5	16.3	17.7	19.8	21.7	23.4	25.0	26.6	28.0
22 LT	1"	4.1	13.0	15.9	18.3	22.5	25.9	29.0	31.8	34.3	36.7	38.9	41.0
31 LT	1-1/4"	5.7	18.0	22.1	25.5	31.2	36.1	40.3	44.2	47.7	51.0	54.1	57.0

Fig 61 Nozzles

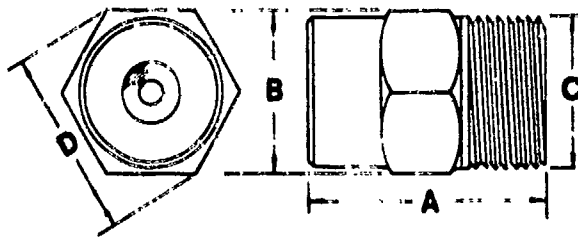
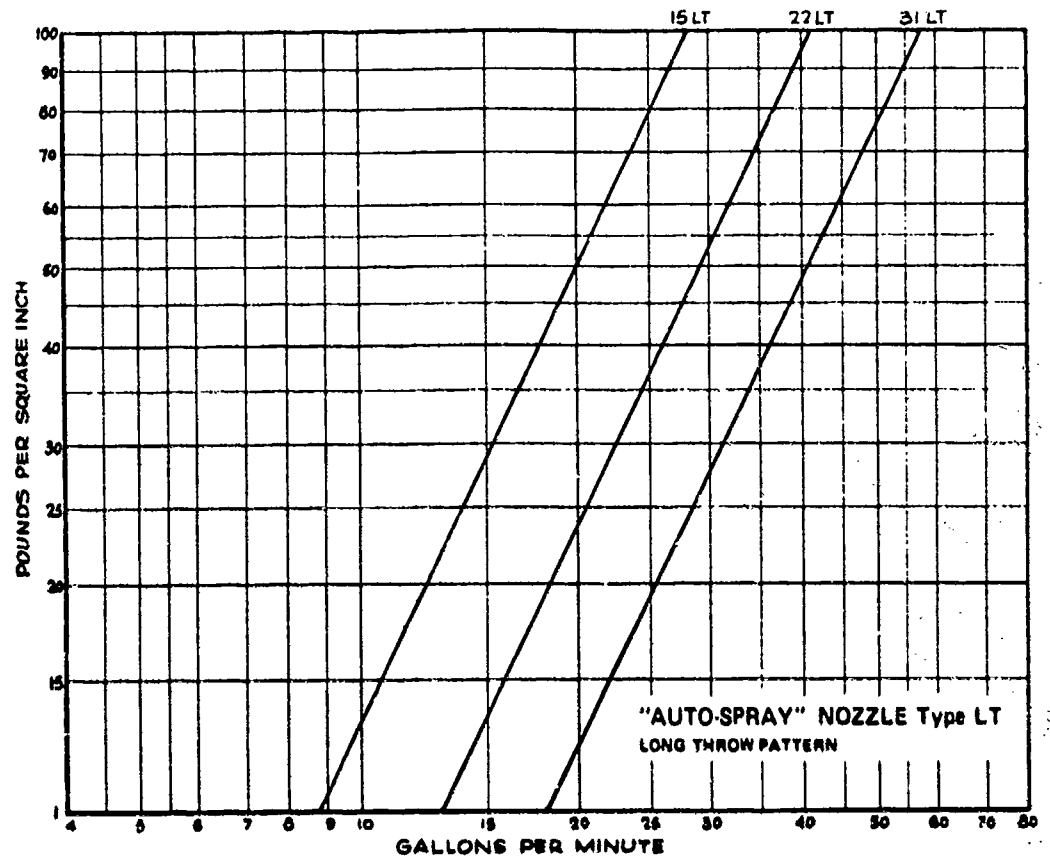


# NOZZLES

Automatic Sprinkler CORPORATION OF AMERICA

J-50

## DISCHARGE CHARACTERISTICS



PHYSICAL CHARACTERISTICS				
NOZZLE NUMBER	DIMENSIONS			
	A	B	C	D
15 LT	2 1/16	1 3/16	1	1 1/32
22 LT	"	"	"	"
31 LT	2 1/2	1 11/16	1 1/4	1 15/16

Automatic Sprinkler CORPORATION OF AMERICA

LITHO U.S.A. 9-72

Fig 62 Nozzles



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